THE CANADIAN ANAESTHETISTS' SOCIETY JOURNAL

Vol. 1, No. 2 OCT., 1954

JOURNAL DE LA SOCIÉTÉ CANADIENNE DES ANESTHÉSISTES

THE CANADIAN ANAESTHETISTS' SOCIETY

EXECUTIVE OFFICERS AND COUNCIL

President

DR. J. P. O'DONNELL, Vancouver

Past President

DR. R. J. FRASER, Hamilton

Vice-Presidents

DR. ALAN B. NOBLE, Kingston
DR. M. W. BOWERING, Regina

Secretary-Treasurer

DR. R. A. GORDON, Toronto

Council

DR. HAROLD HUGHES, Vancouver
DR. C. M. FLETCHER, Edmonton
DR. T. V. DARKE, Regina
DR. H. C. HUTCHINSON, Winnipeg
DR. R. I. PROBERT, Hamilton
DR. S. M. CAMPBELL, Toronto
DR. J. M. WISHART, Peterborough
DR. J. E. GORMAN, Windsor
DR. R. G. B. GILBERT, Montreal
DR. EUGENE ALLARD, Quebec
DR. HAROLD R. GRIFFITH, Montreal
DR. GEORGE D. DONALDSON, Mahone Bay
DR. J. A. MACDOUGALL, Saint John
DR. L. E. PROWSE, Charlottetown
DR. C. D. KEAN, St. John's

for smoother anaesthesia. . .

Largactil

CHLORPROMAZINE

(R.P. 4560)

information and samples on request

204 Youville Square, Montreal

POULENC

A new and versatile local anesthetic agent

CYCLAINE®

HYDROCHLORIDE (HEXYLCAINE HYDROCHLORIDE)

CYCLAINE has now been under clinical investigation for more than five years. Its three primary qualities, of interest to anesthesiologists, are these:

Rapid onset of action

Longer duration than procaine

Few undesirable side effects

The Council on Pharmacy and Chemistry of the A.M.A., which has accepted this new anesthetic, concurs in this statement: "Clinical studies also indicate that, when used for infiltration and nerve block, it is faster and longer acting than an equal concentration of procaine."[1]

CYCLAINE is useful for the following types of anesthesia:

Topical · Endoscopic procedures
Infiltration
Nerve block · Caudal
Lumbar epidural · Spinal

COUNCIL ACCEPTED

Investigators[2-10] agree on these qualities of CYCLAINE:

Effective in low concentration

Rapid in onset

Provides prolonged anesthesia

Wide margin of safety

Of further interest to the anesthesiologist is the fact that CYCLAINE has proved *not* to be antagonistic to para-aminosalicylic acid or streptomycin.[11]

Detailed information, including reprints, will be forwarded upon request to interested physicians. Address: Professional Service Department, Toronto 16, Ont. Films will soon be available showing the use of 'CYCLAINE' in current procedures.

CYCLAINE is presently supplied in these forms:

For infiltration and block anesthesia:
Injection of CYCLAINE Hydrochloride Hexylcaine Hydrochloride 1% supplied in 30 cc. vials, containing 10 mg. CYCLAINE Hydrochloride per cc. (No. 3118). (Isotonic Solution).

For topical anesthesia:
Topical Solution of CYCLAINE Hydrochloride Hexylcaine Hydrochloride 5% is supplied in 60 cc. bottles, containing 50 mg. of CYCLAINE Hydrochloride per cc. (No. 3142). (Isotonic Solution).

For spinal anesthesia:
Injection of CYCLAINE Hydrochloride Hexylcaine Hydrochloride 2.5% with 10% Dextrose is supplied in 2 cc. ampuls, containing 25 mg. of CYCLAINE Hydrochloride per cc. with 10% Dextrose (No. 3119). (Hyperbaric Solution).

SHARP & DOHME
(CANADA) LTD.
TORONTO 16, ONT.

SHARP & DOHME

REFERENCES:

1. Report of the Council on Pharmacy and Chemistry of the A.M.A.: In press. 2. Hudon, F., and Jacques, A.: Proc. Canad. Anesthetists Soc. (1952) p. 34. 3. Orkin, L. R., and Rovenstine, E. A.: Anesthesiology 13:465 (Sept.) 1952. 4. Crawford, O. B.: Anesthesiology 14:278 (May) 1953. 5. Lee, L. W., Davis, E., Jr., and Barmore, J.: To be published. 6. Arcuri, R. A., Newman, W., and Burstein, C. L.: Anesthesiology 14:46 (Jan.) 1953. 7. Hudon, F., and Gendron, P.: Laval med. 18:145 (Feb.) 1953. 8. Ray, E. S., and Vinson, P. P.: Anesthesiology 14:315 (May) 1953. 9. Clark, R. E., Orkin, L. R., and Rovenstine, E. A.: To be published. 10. Stark, E. J.: To be published. 11. Proctor, A. M., et al.: Paper presented at 11th Conference on Chemotherapy of Tuberculosis, V. A., St. Louis, 1952.

Waters Metric Anesthesia Table
and
Waters To and Fro Absorber

Fundamentally the starting tools for scientific gas-anesthesia.

Aiming for the anesthetists
"CONTROL OF LIFE"
at the operating table

FOREGGER
NEW YORK
. . . . since 1914

Leading Books for Anaesthetists

ANESTHESIOLOGY

Edited by Donald E. Hale, Cleveland, Ohio. This new book by forty leading physicians, several of them Canadians provides an orderly presentation of the important extant knowledge of anesthesiology. 772 double column pages, 149 illustrations, 1954, $16.50

REGIONAL BLOCK

By Daniel C. Moore, Seattle, Washington. A handbook for use in the clinical practice of medicine and surgery. A concise outline of the everyday phases of regional analgesia, describing those pertinent blocks that are employed daily. 391 pages, 262 illustrations, 1953, $12.00

•

THE RYERSON PRESS
TORONTO

THE CANADIAN ANAESTHETISTS' SOCIETY JOURNAL

Combining

PROCEEDINGS OF THE CANADIAN ANAESTHETISTS' SOCIETY
CANADIAN ANAESTHETISTS' SOCIETY NEWS LETTER

Editor
R. A. GORDON

Editorial Board
ALAN B. NOBLE
LOUIS LAMOUREUX
E. A. GAIN

Address communications to: The Secretary, Canadian Anaesthetists' Society, 516 Medical Arts Building, 170 St. George Street Toronto 5, Canada

Printed and Published for
THE CANADIAN ANAESTHETISTS' SOCIETY, Incorporated
516 Medical Arts Building, Toronto 5, Canada

by

University of Toronto Press
University of Toronto
Toronto 5, Ontario, Canada

Copyright Reserved

Annual subscription $8.00

Authorized as second-class matter
by the Post Office Department, Ottawa,
Canada

EDITORIAL

Obstetrical Anaesthesia

It is unfortunately true that Anaesthesia for the obstetrical patient has received too little attention from anaesthetists. There have been several reasons for this neglect. Many anaesthetists, being otherwise adequately employed, have shunned obstetrical anaesthesia because of its demands on their time, particularly at night, and because of the numerous rush calls of an emergency nature which it entails. Others have considered it minor anaesthesia, taking little real interest in the unique problems involved. Many members of the profession have undoubtedly believed that the obstetrical patient requires so little anaesthesia in most cases that the services of an anaesthetist are not warranted, and this attitude has been prevalent enough to make it possible in the recent past for a medically sponsored plan for prepaid medical care to make no provision for obstetrical anaesthesia.

The serious need for expert attention to the problems of obstetrical anaesthesia must be apparent to all when it is considered that aspiration of vomitus during delivery remains an important cause of maternal morbidity and mortality, that the part played by anaesthesia in neo-natal death is yet far from being defined, and that many infants still succumb to asphyxial incidents at birth who might be salvaged by the expert care which a qualified anaesthetist can provide.

Fortunately a number of well qualified anaesthetists have in recent years turned their attention to the problems involved in providing analgesia and anaesthesia for the obstetrical patient during labour and delivery. Their studies and experience have resulted in greater understanding of the problems involved, and in the introduction of many new techniques for dealing with these problems. There has also developed an ever-increasing awareness of the benefits to be derived by the patient from intelligent cooperation between the obstetrician and anaesthetist throughout the labour. More thought has been given alike to the factors which produce pain in labour, and to the effect of conventional methods of pain relief on the course of labour.

It becomes increasingly apparent that routine treatment of all obstetrical patients by one method of pain relief is unsatisfactory, if not, in fact, dangerous practice. Yet publications on the subject continue to appear suggesting that all obstetrical anaesthesia should be managed by one technique, to the exclusion of all others. We believe that however satisfactory the results may appear, such an attitude will lead to application of the method blindly, and to the detriment of some mothers and infants.

We have the good fortune to present elsewhere in this issue a series of three papers on various aspects of obstetrical anaesthesia. These illustrate the valuable part being played by the Vancouver group of anaesthetists in the development and evaluation of methods for the relief of pain in labour, and the provision of safe anaesthesia for obstetrical delivery.

EDITORIAL

L'Anesthésie obstétrique

Il est malheureusement vrai que l'anesthésie pour le patient en obstétrique a attiré trop peu l'attention des anesthésistes. Il y a eu plusieurs raisons pour cette négligence. Beaucoup d'anesthésistes, absorbés suffisamment par d'autres occupations, ont évité l'anesthésie en obstétrique à cause des exigences qu'elle réclame en matière de temps, surtout la nuit et à cause des nombreux appels urgents qu'elle sous-entend. D'autres l'ont jugée anesthésie mineure, accordant peu d'intérêt véritable aux problèmes uniques qu'elle présente. Bien des membres de la profession ont sans doute cru que le patient en obstétrique exige si peu d'anesthésie dans la plupart des cas, que les services d'un anesthésiste ne sont pas justifiés, et cet état d'esprit explique pourquoi l'anesthésie en obstétrique n'a pas été compris, dans un passé récent, dans les plans de soins médicaux payés à l'avance.

Le besoin sérieux d'une attention experte accordée aux problèmes de l'anesthésie en obstétrique doit être clair à tous, lorsqu'on considère que l'aspiration du vomitus, pendant l'accouchement reste une cause importante de la morbidité et de la mortalité maternelle, que le rôle joué par l'anesthésie dans la mort néo-natale n'est pas encore bien défini et que beaucoup d'enfants succombent aux incidents d'axphysie pendant la naissance qui pourraient être sauvés par les soins experts fournis par un anesthésiste qualifié.

Heureusement, un nombre d'anesthésistes bien qualifiés ont porté leur attention ces dernières années aux problèmes relatifs à l'administration de l'analgésie et de l'anesthésie en obstétrique pendant les douleurs de l'enfantement et l'accouchement. Leurs études et leur expérience ont conduit à une meilleure compréhension des problèmes et à l'introduction de bien de meilleures techniques destinées à faire face à ces problèmes. On se rend compte de plus en plus des avantages qui peuvent résulter pour le patient d'une entente intelligente entre l'accoucheur et l'anesthésiste pendant l'enfantement. On a étudié davantage les facteurs qui provoquent les douleurs de l'enfantement et le résultat des méthodes conventionnelles du soulagement de ces douleurs.

Le traitement routinier de tous patients en obstétrique par une seule méthode de soulagement des douleurs semble être de plus en plus une pratique insatisfaisante pour ne pas dire dangereuse. Cependant, des études paraissent constamment conseillant que l'anesthésie en obstétrique devrait être administrée par une technique à l'exclusion des autres. Nous sommes d'avis qu'un tel état d'esprit, les résultats si satisfaisant qu'il soient, mènera à l'application aveugle de la méthode, au détriment de certaines mères et des enfants.

Nous avons le bonheur de pouvoir présenter dans cette édition du journal, une série de trois études sur les divers aspects de l'anesthésie en obstétrique. Elles illustrent le rôle précieux joué par le groupe d'anesthésistes de Vancouver dans le développement et l'évaluation de méthodes pour le soulagement des douleurs pendant l'enfantement afin de pourvoir une anesthésie sûre pour l'accouchement.

COMPLICATIONS ARISING DURING TRANSURETHRAL RESECTION OF THE PROSTATE

MAX MINUCK, M.D.*

THE most common complications arising during transurethral resection of the prostate are, hemorrhage, perforation, and intravascular hemolysis. The anaesthetist, by observing certain signs and symptoms, is able to recognize these complications early and reverse dangerous trends. Since the diagnosis of the first two complications is relatively easy and well known, they will not be discussed in the present paper. We will deal only with the diagnosis, prevention and treatment of intravascular hemolysis.

Hemolysis during transurethral resections is dangerous firstly, because it is often followed by anemia, jaundice and prolonged morbidity. Secondly hemolysis, if not corrected, may be followed by shock. An occasional death from shock within 36 hours of the operation has occurred where blood loss alone has been insufficient to fully explain the fatal outcome of the case. Thirdly, and most important, hemolysis is one of the factors contributing to lower nephron nephrosis in the postoperative period. McLaughlin states that Emmet has estimated that 20% of the deaths following transurethral resections are due to uremia (1) the end result of fatal forms of lower nephron nephrosis by free hemoglobin in the plasma is obscure, but Yuile (2) has been able to demonstrate a synergistic action between free hemoglobin and renal ischemia with the production of severe renal damage. In transurethral resections the renal ischemia may be produced by shock, hemorrhage or previously diseased kidneys.

Hemolysis occurring during transurethral resection of the prostrate was first recognized by McLaughlin and his co-workers in 1946 (1). Both he, Creevy and Webb (3), and others (4, 5) published cases of fatal hemolytic reactions during transurethral resections in which the distal convoluted tubules were found to be obstructed with heme pigment. This picture is similar to that found in fatalities from transfusions with incompatible blood. McLaughlin postulated that the water used as the irrigating fluid entered the circulation via opened prostatic veins, and being a hypotonic solution, hemolyzed the red blood cells. Creevy had reported that Emmet and Foley had previously observed spurts of red urine emerging from the ureteric orifices during these procedures (3).

Proving that the water did indeed enter the circulation during transurethral prostatic resections was not too difficult. Landsteiner (4), by labelling the irrigating fluid with sodium salicylate, was able to show that the fluid entered the circulation. Where glucose had been used as the irrigating fluid marked rises in plasma glucose were observed.

Many fluids have been used to replace water as the irrigating fluid in order to prevent the occurrence of intravascular hemolysis. These are, glucose 4% (6), urea 0.9% (7), urea 1.8% (7), glucose 4% to which had been added 1 unit of

*From the St. Boniface Anaesthetic Clinic and St. Boniface Hospital, St. Boniface, Manitoba.

insulin per gram of glucose (8), glycine 1.1% (9), mannitol 3% (10), and most recently Cytal* (11). The solution used must have certain characteristics and lack others:—it must be non-electrolytic, transparent, non-irritating, capable of being metabolized, isotonic, and lastly easy to prepare and hence cheap. Of these glycine 1.1% first suggested by Nesbitt appears to be the most suitable. Although he recognized that glycine 1.1% is at the lower limits of isotonicity, Nesbitt was unable to demonstrate any gross hemolysis in over 1000 cases (12).

Material and Methods

In our series there were 191 transurethral resections performed on 188 patients at the St. Boniface Hospital between Jan. 1st, 1952 and Dec. 31st, 1953. With the exception of one case, a short revision operation, spinal anaesthetic was exclusively used. We used between 6 and 10 mgms. of 1% pontocaine diluted with an equal volume of 10% glucose to make it hyperbaric. The optimum level of analgesia was L 1. At this level of analgesia bladder pain was obtunded without any disturbance of the patient's blood pressure. At this level a few pain fibres to the bladder and pain fibres innervating the peritoneum were not affected so that dangerous overdistension of the bladder produced pain and perforations of the bladder were signalled by the early onset of pain and abdominal rigidity. Furthermore, by paralyzing the parasympathetic vasodilator fibres to the prostatic plexus and allowing unrestricted sympathetic vasoconstrictor activity, bleeding was considerably diminished (13). At the end of every operation a sample of blood was taken from a forearm vein and tested for the presence of hemolysis. If, during the operation, signs and symptoms suggestive of hemolysis appeared, then a sample of blood was withdrawn at that point, and treatment instituted before the result was obtained from the laboratory. The technique of testing for hemolysis was the essence of simplicity. The sample of blood was carefully withdrawn into a dry 10 ccs. syringe and then gently placed in a centrifuge tube and centrifuged for 30 minutes and the supernatant fluid examined for hemolysis. No quantitative examination was done. A slight pink tint was reported a slight hemolysis, a definite red tinge as hemolysis, and a dark red colour as marked hemolysis. Records were kept for every case for age, blood loss, duration of operation, preoperative condition of the patient, hemolysis, irrigating fluid used, and whether clinical signs of hemolysis were present or absent.

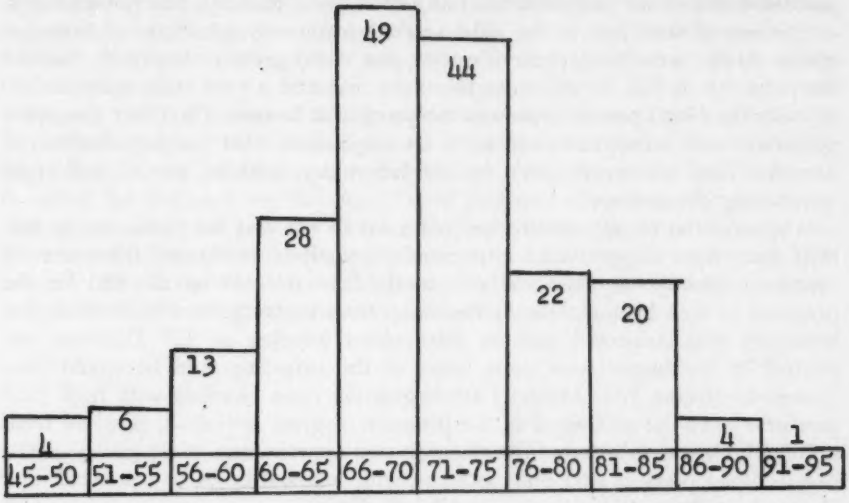
In addition, Mr. Coleman, biochemist at St. Boniface Hospital, conducted in vitro experiments on the hemolyzing properties of the following solutions:—

1. Hemolyzed fluid taken directly from the bladder during the course of an operation where water was being used as the irrigating fluid.
2. Emulsions were made of prostatic tissue removed at operation.
3. Sterile water.
4. Glycine in concentrations varying from 0.8% – 1.5%.

*Cytal is the official trade name adopted by the Cutter Laboratories of Berkeley, California for the following solution:—Sorbital 2.73 gm./100 ccs., Mannitol .546 gm./100 ccs., Methylparahydroxybenzoate .0005 gm./100 ccs., Propylparahydroxybenzoate .0001 gm./100 ccs., Butylparahydroxybenzoate .0001 gm./100 ccs.

TABLE I

THE AGE DISTRIBUTION IN 191 TRANSURETHRAL RESECTIONS OF THE PROSTATE GLAND.



Average age - 70.9 years.

Median age - 71 years.

Complications

Blood loss over 600 ccs.–15 (thirteen were associated with hemolysis.)

Perforations occurred twice.

Deaths within one week of operation–5.

Mortality rate–2.61%.

The average or arithmetic mean age in our series was 70.9 years and the median was 71 years; 73.3% of the patients were over 65 years of age and 25 were over the age of 80. The youngest in the series was 46 and the oldest 93. Many of these patients (22.4%) suffered from varying degrees of cardiovascular insufficiency and emphysema. So-called "chronic bronchitis" and asthma were not uncommon preoperative findings. In spite of this, with careful preoperative preparation, and when hemorrhage, hemolysis and perforations were avoided or recognized and treated early, the operative and postoperative courses were amazingly smooth.

Blood loss of over 600 ccs. was encountered 19 times and 13 of these were associated with hemolysis, illustrating an expected finding, namely; that where large venous sinuses are opened, hemolysis is more likely to occur.

Perforations occurred on 2 occasions, in one of the cases the perforation was very small. In the other case, the operation was abandoned and a retropubic prostatectomy was carried out successfully at a later date.

With the onset of hemolysis a fairly typical picture presents itself during the resection. The patient may begin to complain of a sudden feeling of weakness and tiredness, or he may start to chill and become clammy. Not uncommonly, a tightness of the chest is the most marked feature—symptomatic of bronchospasm. At the same time, or shortly after, the blood pressure begins to rise and the pulse rate to fall. In our series hemolysis occurred a total of 57 times and in 23 cases the blood pressure rise was the prominent feature. The other symptoms occurred more infrequently. It must be emphasized that varying degrees of hemolysis can occur, as shown by the laboratory, without any clinical signs manifesting themselves.

Whenever the blood pressure was observed to rise and the pulse rate to fall, or if other signs suggestive of intravascular hemolysis manifested themselves, a sample of blood was taken and sent to the laboratory to be checked for the presence of free hemoglobin. At the same time the surgeon was notified that hemolysis was suspected and an intravenous infusion of 15% Dextrose was started. If the surgeon was using water as the irrigating fluid he would then change to glycine 1.1%. Attempts at coagulating open bleeders with high fluid pressures were not prolonged in the presence of gross hemolysis; pressure from a Foley bulb was substituted. Restlessness and apprehension often preceded the rise in blood pressure and mild sedation with minimal doses of pentothal, and Demerol in 20 mgm. doses were usually effective.

If hemolysis was definitely established by the laboratory then 750 ccs. of 15%

FIGURE 1

Date—May 28th

Age—75

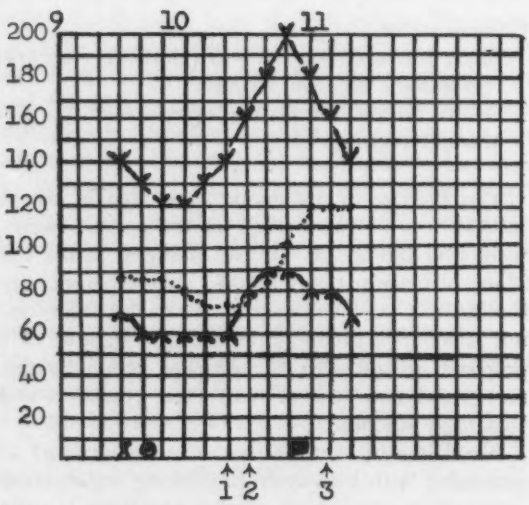
Name—Essers

Pre-op condition—Diabetes

Anaesthetic—1% Pont. 9 mgm.

Blood loss—460 ccs.

Hemolysis—Marked



1. Patient complaining of neck pains and chills.
2. Glucose 15%—750 ccs. started.
3. Patient returned to the ward.

Glucose was given twice daily for three post-operative days and the patient observed closely for oliguria and anuria. The use of 15% glucose was first suggested to us by Dr. Earl Stephenson and followed along the line of treatment as outlined by Thorn (14). Almost invariably when this treatment was instituted, the blood pressure rise was reversed, and the postoperative course remained smooth.

Figures 1 and 2 represent the operative courses of two of the cases in our series that exhibited signs and symptoms of intravascular hemolysis. It may be noted that in case 1 the onset of hemolysis was characterized by chills, whereas in case 2 the first sign was the rising blood pressure. Hemolysis was proven by testing samples of the patients' blood, taken at the first suggestion of hemolysis. On account of the marked hemolysis found in the first case he was given 1500 ccs. of 15% glucose for three postoperative days. The postoperative courses, except for mild and brief hypotension, were smooth.

FIGURE 2

Date—Nov. 5th

Age—76

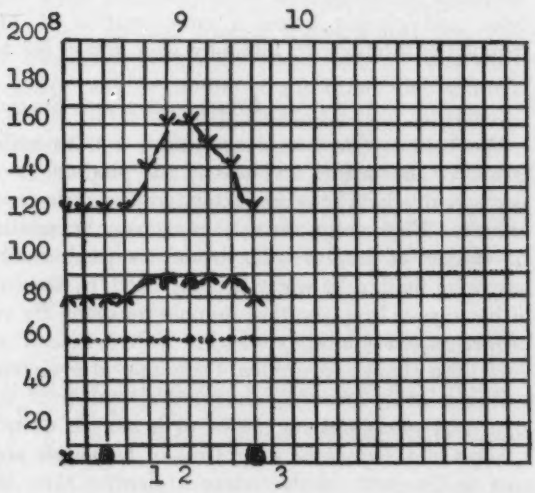
Name—Mayhew

Pre-op condition—Negative

Anaesthetic—1% Pont. 9 mgm.

Blood loss—902 ccs.

Hemolysis—positive



1. Glucose 15% started.
2. Blood taken to test for hemolysis—positive.
3. Blood started.

To repeat—signs and symptoms were present in about 50% of the cases in which hemolysis was proven to have occurred.

One sees from Table II that neither fluid taken from the bladder during a transurethral resection, mixed with the burned products of the coagulating and cutting currents, nor emulsions of prostatic tissue removed at operation, were

TABLE II

Hemolyzing Properties of Certain Solutions	
Fluid from the bladder	None
Emulsions of Prostatic Tissue	None
Sterile water (distilled)	Marked
Glycine solutions:	
0.8%	Marked
0.9%	Marked
1.0%	None
1.1%–1.5%	None

hemolytic in themselves. Sterile distilled water was, of course, markedly hemolytic, and glycine below a concentration of 1.0% but not above 1.0% was hemolytic; dilutions to 1.5% only were tested for hemolytic properties.

Conclusions and Summary

We believe that hemolysis during a transurethral resection of the prostate is one of the factors involved in the production of a lower nephron nephrosis postoperatively. The other factors are hemorrhage, shock and previously diseased kidneys. These latter three factors may be minimized by obvious means and the factor of intravascular hemolysis diminished by the use of an isotonic irrigating fluid, or if water is being used, by the early recognition and treatment of hemolysis. It is true that isotonic solutions, by virtue of their non-hemolyzing properties, do interfere somewhat with vision within the bladder, but it requires very little change in surgical technique to overcome this obstacle.

In our series hemolysis occurred a total of 57 times, and in 50% of the cases signs and symptoms suggestive of hemolysis occurred.

Signs and symptoms suggestive of hemolysis are, a sudden feeling of weakness or tiredness, chills and/or a clammy skin, bronchospasm, a rising blood pressure usually accompanied by a slowing of the pulse rate.

By following the principle of early recognition and treatment there were, in our series of 191 cases, no instance of postoperative anuria, nor was lower nephron nephrosis a feature in any of our postoperative deaths.

Résumé

L'hémolyse intravasculaire pendant l'excision transurétrale du prostate est une complication assez commune. Cette complication si elle est parfois accompagnée de choc et quelquefois d'hémolyse peut contribuer au développement

d'une néphrose du néphron inférieur. On pense que l'hémolyse pendant l'excision transurétrale se développe ainsi: le fluide employé comme agent d'irrigation est généralement l'eau. Cette eau peut entrer dans la circulation par voie d'une ouverture des veines prostatiques, et, étant hypotonique, hémolysera les cellules rouges du sang.

Dans 191 cas à l'hôpital St Boniface le sang du patient, à la fin de chaque opération, a été régulièrement examiné pour y déterminer la présence d'hémolyse. Dans tous nos cas la technique employée a été une basse anesthésie lombaire jusqu'au lombaire I. L'hémolyse observée visuellement s'est déclarée en tout 57 fois pour une incidence de 29%.

Les signes et les symptômes de l'hémolyse sont les suivants: le patient se plaint de faiblesse et/ou de fatigue, peau froide et moite, toux coqueluchoïde, augmentation de la pression artérielle et ralentissement du poulx. Dans notre série les signes et les symptômes indiquant l'hémolyse se sont déclarés dans plus de 50% des cas où l'hémolyse a été confirmée par une examination visuelle du sang du patient. L'augmentation de la pression artérielle et le ralentissement du poulx ont été les symptômes constants et se sont déclarés dans 23 sur 57 cas. On a aussi noté que l'hémolyse peut être présente sans produire de signes ou symptômes.

La prévention est possible par l'emploi d'un fluide d'irrigation isotonique telle la glycine 1.1 à 1.5%, le Cytal etc. Le traitement consiste à commencer avec 750 ccs de glucose à 15%, réduction d'essais prolongés de coagulation du sang sous pression élevée de fluide, le demerol pour l'agitation et substituer une solution isotonique comme fluide d'irrigation. Envoyer un specimen du sang au laboratoire à fin de confirmation du diagnostic et si l'hémolyse est marquée poursuivre alors avec le glucose à 15% deux fois par jour pendant trois jours et tenir un compte exact de l'absorption et de l'émission urinaire des patients.

Dans notre série, lorsque le régime précité a été institué, la hausse de la pression artérielle a été renversée et les progrès après l'opération ont été suivis.

REFERENCES

1. McLaughlin, W. L., Holyoke, J. B., and Bowler, J. P. Oliguria Following Transurethral Resection of the Prostate, J. of Urology: 58: 47, Jan. 1947.
2. Yuile, C. L., Gold, M. A., and Hinds, E. G. Hemoglobin Precipitation in Renal Tubules; a Study of its Cause and Effect, J. of Exp. Med. 82: 351, 1945.
3. Creevy, C. D., and Webb, E. A. A Fatal Hemolytic Reaction Following Transurethral Resection of the Prostate, Surgery: 21: 56, Jan. 1947.
4. Landsteiner, E. K., and Finch, C. A. Hemoglobinemia Following Transurethral Resection of The Prostate, New Eng. J. of Med.: 237: 310, Aug. 28th, 1947.
5. Woodruff, L. M., and Firminger, H. I. Hemoglobinemic and Hemoglobinuric Nephrosis Complicating Transurethral Resections, J. of Urology: 62: 168, Aug. 1949.
6. Creevy, C. D. Hemolytic Reactions During Prostatic Resections, J. of Urology: 58: 125, Feb. 1947.
7. Evert, C. E. A Clinical Comparison of The Use of Glucose and Urea in Irrigating Solutions of Transurethral Resections, J. of Urology: 62: 736, Nov. 1949.
8. Dees, T. A., Stewart, W. D., Meares, E. F., and Orr, L. M. Modified Irrigating Solutions for Transurethral Resections, J. of Urology: 59: 212, Feb. 1948.
9. Nesbitt, R. M. and Glickman, S. L. The Use of Glycine Solution as An Irrigating Fluid During Transurethral Resection, J. of Urology: 59: 1212, June, 1948.

10. Goodwin, W. E., Cason, J. P., and Scott, W. W. Hemoglobinemia and Lower Nephron Necrosis Following Transurethral Resection, J. of Urology: 65: 1075, June, 1951.
11. Hardie, W. R., and Johnston, F. F. The Effect on Red Cell Fragility of a Polyhydric Alcohol Irrigating Medium in Transurethral Resection, Am. J. of Clin. Path.: 22: 1028, Oct. 1952.
12. Garske, G. L., Phares, O. C., and Sweerser, T. H. The Status of Irrigating Fluids for Transurethral Resections: J. of Urology: 62: 322, Sept. 1949.
13. Rowbotham, S. Hemostasis in Prostatectomy, Anesthesia: 1: 70, 1946.
14. Thorn, G. W. Treatment of Renal Insufficiency, J. of Urology: 59: 119, Feb. 1948.

HOW SAFE IS SPINAL ANESTHESIA IN PRESENT DAY PRACTICE?*

C. R. STEPHEN, M.D.**

FROM time to time reassessment of accepted techniques of anesthetic practice are necessary, in order to place the methods in proper perspective in relation to recent developments. Spinal analgesia falls into such a category. In recent years sharp criticism has been directed towards this technique, one author (1) going so far as to state, "From a neurological point of view, we give the opinion that spinal anesthesia should be rigidly reserved for those patients unable to accept a local or general anesthetic." The advent of the muscle relaxant drugs has obviated to some degree the argument that subarachnoid block is the only method of obtaining profound relaxation unless deep planes of general anesthesia be initiated. In the light of this change, some anesthetists see fewer indications for intraspinal nerve block.

In any consideration of the relative safety of one technique over another, it should be emphasized that a definite calculated risk is inherent in any attempt to produce pain relief. Even local anesthesia contributes its share of undesirable complications (2). Too often this overall hazard is forgotten, particularly in articles prepared for lay consumption.

One of the unfortunate facts concerning spinal anesthesia is that the neurological complications occasionally associated with it are usually not only permanent but also incapacitating. The persistence of these complications and the doubt as to their exact etiology, has focussed an undue amount of attention on them (1) (3) (4). Details as to the incidence of morbidity following spinal anesthesia are difficult to gather, although in a recent review of 10,000 patients (5) the occurrence of permanent local neurological damage was nil. With regard to mortality incurred, a survey of 857,000 cases indicates that the death rate associated with spinal anesthesia is less than that accompanying general anesthesia (6).

It is the purpose of this discussion to review some of the known hazards which may accompany subarachnoid analgesia, with the hope that the prophylactic or therapeutic measures mentioned may help to improve the status of this technique in the professional and public mind.

Technical Administration

The axiom that a technique of anesthesia is as safe as the experience and ability of the physician applying it holds true in spinal anesthesia. The injection of a local anesthetic drug into the subarachnoid space is a procedure which, if carried out adequately, requires skill and care. The preparation of the anesthetist and the back of the patient should be just as thorough and painstaking as the preparation of the surgeon and the front of the patient for an aseptic incision.

*Presented at a meeting of the Ontario Division Canadian Anaesthetists' Society, Ottawa, April 3, 1954.

**From the Division of Anesthesia, Duke University Hospital and School of Medicine, Durham, North Carolina, U.S.A.

The results of carelessness or short cuts by the anesthetist could be more devastating to the patient than any lapse on the part of the surgeon.

1. *Assessment of Patient.* Prior to administration, a knowledge of the medical background of the patient is important. A history of previous or existing neurological disease is probably a contraindication to spinal anesthesia. A recrudescence of previous symptoms following operation will be associated with the subarachnoid injection, and it will be difficult to disprove a cause and effect relationship. Medicolegal proceedings have been initiated linking paraesthesias following spinal anesthesia to poliomyelitis whch occurred 20 years previously (3).

Fear or objection on the part of the patient to a spinal block must not be brushed away lightly. Sufficient and well planned premedication may help to obviate the overall apprehension associated with anesthesia and operation. But if the patient is adamant in his refusal of spinal injection, even after a thorough explanation in the preoperative visit, then other methods of pain relief should be used. The present day anesthetist is sufficiently versatile that the desires of the patient usually can be heeded.

2. *Preparation of Equipment.* It is acknowledged universally today that spinal trays should be autoclaved before their use. However, care should also be taken to ensure that syringes and needles are properly prepared prior to autoclaving. A recent report (7) describes neurologic sequelae developing from a detergent in which syringes were washed before being sterilized.

3. *Positioning of Patient.* A single, direct insertion of the needle into the subarachnoid space is much more to be desired than repeated, frustrating attempts to find the canal. The latter undermines the confidence of the patient in the administrator and the associated trauma may be the cause of postoperative low back pain. A true lateral position with the patient curled up "like a kitten" will widen the spaces between the lumbar spines maximally and allow easy access to the cerebrospinal fluid. In the prone position an exaggerated jacknife position will accomplish the same effect.

4. *Aseptic technique.* Ideally the lumbar area of the back should be shaved. An antiseptic solution should be applied at least twice, working outward from the proposed site of injection. Prior to insertion of the spinal needle, the site of injection should be allowed to dry or be wiped off. Chemical arachnoiditis can occur from the inadvertent introduction into the spinal canal of cleansing solutions (8). Aseptic technique will be enhanced if the anesthetist ensures that his gloved hands do not touch any part of the needles to be inserted into the patient's back.

5. *Care in Puncture.* The use of small bore 24 to 26 gauge needles is felt to lessen the possibility of postspinal headache. The exact cause of this vexing complication is unknown, but majority opinion adheres to the so-called leakage theory. This supposes that escape of cerebrospinal fluid from the hole in the dura made by the needle is sufficient to cause stretching of the cerebral vessels and associated headache. The use of thin needles, however, increases the technical difficulty of lumbar puncture. If the bevel of the needle employed is facing either caudad or cephalad, there will be less potential trauma to the dura.

Occasionally, as the dura is entered, the patient will complain of sharp pain radiating down one of the extremities. This discomfort is due usually to the needle impinging on a nerve root. The position of the needle in the canal should be altered before injection of the anesthetic solution, as permanent neurologic sequelae have been reported to follow injection into a nerve root within the subarachnoid space (9).

From time to time blood is obtained mixed with cerebrospinal fluid when the stilette is withdrawn from the needle. This "bloody tap" is due most frequently to perforation by the needle of the venous plexus which lies between the anterior aspect of the subarachnoid space and the bodies of the vertebrae. If the needle is withdrawn one or two millimeters, it will be more properly within the subarachnoid space, the blood will disappear rapidly, and the procedure may continue. If in spite of all efforts the blood continues to appear, a new interspace should be selected for the tap.

6. *Anesthetic Drugs.* Most of the drugs prepared for spinal anesthetic use on this continent are of such a high standard that their purity is seldom questioned. However, considerable discussion has appeared in recent years regarding the safest way of sterilizing the drug ampoules prior to use. Soaking in antiseptic solutions may lead to contamination of the drug by penetration through cracked or imperfect ampoules. Coloring the sterilizing solution with a dye such as methylene blue will aid in detecting such contamination (10), but even with this help the naked eye may not recognize the seepage (8). "Niphinoid" compounds are an aid in this regard, as such preparations dissolve with one or two drops of liquid. The best way of circumventing this hazard entirely is to have all ampoules autoclaved with the tray or as a separate package. Epinephrine is the only drug commonly employed for spinal injection which cannot be autoclaved at least once.

At times the inherent toxicity of spinal anesthetic drugs to nerve tissue has been incriminated in patients suffering neurological sequelae. None of the compounds employed commonly in practice today are believed to exert such effects, unless they be injected in too high concentrations. For example, procaine hydrochloride in concentrations up to 5 per cent is considered safe, but a ten per cent solution is capable of producing permanent nerve damage. All other factors considered equal, the more dilute the injected solution, the less likelihood of direct nerve involvement (11).

In the last ten years it has become a common practice to extend the duration of spinal anesthesia by the direct injection of vasoconstrictor drugs into the subarachnoid space. Recent evidence (12) suggests that in the total doses employed clinically, these drugs exert no deleterious effects on spinal cord or meninges.

It is difficult to conceive of generalized toxic manifestations occurring from overdosage of the anesthetic drug used for spinal analgesia. However, true sensitivity can occur (13), although the incidence of this complication has been estimated to be as low as 1 in 200,000 (14). Such reactions appear usually as generalized convulsive movements beginning within 20 minutes of the time of injection. They can be controlled by the inhalation of oxygen and the intravenous administration of a barbiturate.

Early Complications

1. Fear in a patient may become uncontrollable after subarachnoid block. One should do his best to allay dread by psychological comfort, but at the same time should not hesitate to employ narcotic or sedative drugs as indicated. In order to produce the most beneficial and predictable results, such compounds are best given intravenously (Table I). Before administration one should

TABLE I

SEDATION

Drug	Dose (Intravenous)*
Morphine	5 mg.
Demerol	25 mg.
Seconal	50 mg.
Nembutal	50 mg.

*Administer every 3 to 5 minutes until drowsy.

establish that the restlessness shown by the patient is not due to anoxia. This point in differential diagnosis may be difficult to make, and if one is in doubt, the sedative drugs should be withheld. Finally, the anesthetist should not be too proud to begin light general anesthesia to complement his conduction block, should the individual situation warrant it.

2. *Cardiovascular Reactions.* Hypotension and bradycardia are the principal complicating factors seen, and result more or less directly from the ascending paralysis of the sympathetic nervous system. Uncompensated vasodilatation of arterioles and unopposed action of the parasympathetic system are involved in the pathogenesis of the alterations. The anesthetic level may be controlled most adequately by employing either hypobaric or hyperbaric solutions, and thus enlisting the aid of gravity. Extreme caution should be exercised in patients with large abdominal tumors, as in such individuals the anesthetic solution may rise most rapidly in the subarachnoid space. Prophylactic measures against hypotension include the administration of a vasopressor subcutaneously before the conduction block. This is indicated particularly in the older age group with pre-existing hypertension. In such patients sudden falls in blood pressure are more dangerous than occasional elevations. The bradycardia may be controlled by small intravenous doses of a parasympatholytic drug such as atropine. Under all circumstances the safety of the patient is enhanced if an intravenous drip is begun prior to beginning the block. With an open vein sudden falls in blood pressure, neurogenic in origin, may be reversed rapidly and effectively by one of several vasopressor drugs (Table II).

3. *Respiratory System.* A conduction block which ascends higher than the 9th thoracic dermatome is likely to cause some degree of intercostal paralysis. Careful observation of respiratory movements should be maintained and attention paid to subjective complaints of difficulty in breathing. Oxygen administration by nasopharyngeal catheter is indicated if any doubt exists in the mind of the anesthetist regarding adequacy of tidal volume. The application of a face-mask with the administration of high oxygen concentrations, along with

TABLE II

VASOPRESSORS

Drug	Dose (mg.)	
	I.V.	I.M. or S.C.
Ephedrine	10–25	50
Methedrine	3–5	10–20
Vasoxyl	3–5	10–20
Neosynephrine	1–3	3–5

Levophed—continuous drip only—4 mg. to 1000 cc.
Vasoxyl—continuous drip—20 mg. to 1000 cc.

assisted respirations, may be necessary at times. The immediate availability of positive pressure oxygen during spinal anesthesia should not require emphasis in modern anesthetic practice.

4. *Nausea and Vomiting.* When these complications occur within thirty minutes of the anesthetic administration, they are due usually to hypotension or anoxia, and the condition can be corrected as outlined above. When retching occurs later in the procedure, it is associated usually with traction on the mesentery by the surgeon or by an unusual position, e.g. prone, in which the patient may be lying. If anoxia can be ruled out, the cautious administration of sedative drugs along with oxygen will often alleviate the condition. At times light general anesthesia may be necessary.

5. *Inadequate Analgesia.* Failure to obtain satisfactory pain relief after spinal injection is believed due in nearly every instance to technical errors. Perhaps the most common mistake is the placement of the bevel so that it lies partially inside and partially outside the subarachnoid space. If one can obtain a free flow of cerebrospinal fluid by aspiration with a syringe both before and after the anesthetic injection, then the possibility of failure is remote. Rachi-resistant patients will be seen perhaps only once or twice in the lifetime of the anesthetist.

Late Complications

After general anesthesia both surgeons and patients expect to some extent metabolic upsets which lead to such symptoms as nausea, retching, headache, tinnitus, and so on. When such disturbances appear after spinal block, great furor is created and immediate remedies sought. Some of these symptoms may be associated with the surgical condition itself.

1. *Headache.* The commonest theory called upon to explain postspinal headache is that of abnormal leakage of cerebrospinal fluid through the hole in the dura made by the spinal needle. Actually the true and undeniable cause of this distressing symptom is unknown. Until the pathogenesis has been determined unequivocally, numerous and varied methods of treatment will persist. The best treatment for any one anesthetist is the one with which he has had the largest number of good results.

2. *Nausea and Vomiting.* This complication is not common, and may be associated with rough handling of the patient while the nerve block is still effective. Too early ingestion of food may also precipitate nausea.

3. *Backache.* This symptom perhaps is more common than anesthetists realize. It may not begin until the patient is ambulatory, and the anesthetist may not learn of it until the patient is hospitalized at some future time. Like headache, the etiology of spinal backache certainly is obscure. However, it is known that muscles tend to protect joints from undue strain or stretching. If the muscles of the back become completely paralysed and lose all tone, the lumbosacral and vertebral joints will be subjected to most unusual direct stresses. Stretching or actual alteration in alignments may occur, and these give rise to pain in the post-operative period. A certain amount of protection against this disturbance can be obtained by placing a small pillow under the back in the lumbar area in order to preserve the normal lordosis. Undue stretch may be alleviated by placing a second pillow behind the knees.

4. *Cranial Nerve Palsies.* The exact cause of this usually self-limiting complication is unknown, but majority opinion believes that its inception is related to the leakage of fluid from the subarachnoid space, with consequent stretching of a cranial nerve, usually the sixth. The stretching is believed to cause a temporary interference with function (15) (16). However, one cannot rule out the possible involvement of "toxic" factors introduced from without.

5. *Cauda Equina Syndromes.* Damage to the nerve trunks lying within the subarachnoid space is referred to commonly as a cauda equina syndrome. The alteration which occurs within the nerve tissue usually is irreversible. Most commonly this syndrome follows the injection of a local anesthetic solution intrathecally. However, its occurrence is rare and follows no special pattern, nor is it associated with any particular sequence of events. Once again the etiology of this most serious complication is unknown. There seems general agreement that it is due to the insertion of some substance, chemical or bacterial, into the subarachnoid space, which under certain circumstances can cause loss of function in certain nerves. The possibility of its occurrence can be reduced by adhering to basic principles such as outlined above.

Summary

Spinal analgesia may be considered as safe as any method of pain relief, provided meticulous care is observed, common sense is exercised, and the technique is reserved for patients who want it, surgeons who desire it, and anesthetists who can perform it intelligently.

Résumé

De temps en temps une réévaluation des techniques courantes dans la pratique de l'anesthésie est nécessaire, afin de situer les méthodes à leur juste place en vue des développements récents. Le but de cette discussion est de passer en revue certains des hasards connus qui peuvent accompagner l'analgésie arachnoïde, avec l'espoir que les mesures prophylactiques et médicamenteuses indiquées, pourront aider à améliorer l'état de cette technique dans l'esprit des professionnels et du public.

Dans toute considération de la sécurité relative d'une technique comparée à une autre il faut reconnaître que tout effort pour amener un soulagement de la

souffrance comporte un risque précis et déterminé. Il est difficile de rassembler des détails sur l'incidence de la morbidité suivant l'anesthésie lombaire, quoique dans une revue récente de 10,000 patients (5) la présence de détériorations neurologiques locales a été zéro. Un examen de 857,000 cas indique que le taux de la mortalité relatif à l'anesthésie lombaire est moins élevé que celui qui est calculé pour l'anesthésie générale (6).

Il ne faut pas imposer l'anesthésie lombaire aux patients qui la refusent et toute histoire de désordre neurologique antérieur ou plainte est une contre-indication. Les complications seront évitées en nettoyant scrupuleusement l'équipement avant de le mettre dans l'autoclave, en observant strictement les principes d'une aseptie, en suivant une technique soigneuse et précise dans l'exécution de la ponction lombaire. Des solutions diluées des drogues anesthésiques locales devraient être employées pour l'injection, et l'injection ne devrait pas être faite en présence de paresthésie produite par la canule, ou d'un écoulement continu de sang (bloody tap). Dans chacun des ces derniers cas on devra choisir un autre espace intermédiaire.

Les premiers complications de l'anesthésie lombaire se rattachent à la peur, à l'hypotension provenant de la paralysie sympathétique, et à l'anoxie due à la paralysie des muscles respiratoires. Ces complications seront traitées par l'emploi approprié de sédatifs ou anesthésie générale, de vaso-presseurs et d'oxygène. Les dernières complications sont maux de tête, nausées, vomissements, douleurs de reins et complications neurologiques. Chaque anesthésiste a sa propre méthode préféré de traitement des maux de tête. La nausée et le vomissement proviennent généralement d'un traitement dur du patient ou d'une ingestion prématurée de nourriture. On évitera les maux de reins en plaçant un petit oreiller sous la partie lombaire de l'épine dorsale et un autre sous les genoux pendant que le patient repose sur la table d'opération. On évitera les séquelles neurologiques par le choix approprié du patient et une technique soignée.

REFERENCES

1. Kennedy, F., Effron, A. S., Perry, G. Grave Spinal Cord Paralysis Caused by Spinal Anesthesia. Surg., Gyn. & Obst. 91:385–398, Oct. 1950.
2. Davis, D. A. Some Hazards of Local Anesthetic Procedures. N. C. Med. J. 15:127–131, March, 1954.
3. Wilson, G., Rupp, C., Wilson, W. W. Dangers of Intrathecal Medication. J. A. M. A. 140:1076–1079, July, 1949.
4. Bergner, R. P., Roseman, E., Johnson, H., Smith, W. R. Severe Neurologic Complications Following Spinal Anesthesia: Report of 6 Cases. Anesthesiology 12:717–727, Nov., 1951.
5. Sadove, M. S., Levin, M. J. Neurological Complications of Spinal Anesthesia. Ill. Med. J. 105: April, 1954.
6. Cole, F. A Defense of Spinal Anesthesia. Anesthesiology 13:407–415, July, 1952.
7. Winkelman, N. W. Neurologic Symptoms Following Accidental Intraspinal Detergent Injection. Neurology 2:284–291, July–Aug., 1952.
8. Searles, P. W., Nowill, W. K. The Role of a Sterilizing Solution in the Cauda Equina Syndrome Following Spinal Anesthesia. New York J. Med. 50: 2541–2544, Nov., 1950.
9. Eversole, V. H. Complications of Spinal Anaesthesia. Surg. Clin. North America 30:693–703, June, 1950.

10. Steinberg, B. L. Ampule Contamination in Spinal Anesthesia. Anesthesiology 11:257–258, March, 1950.
11. Griffith, H. R. Safety Factors in Spinal Anesthesia. Anes. & Anal. 31: 367–371, Nov.–Dec., 1952.
12. Wu, J. J., Hamagel, D. L. A., Brizzee, R. R., Smith, S. M. Neurological Effects Following Intrathecal Administration of Vasoconstrictor Drugs in Rhesus Monkeys. Anesthesiology 15171–88, Jan., 1954.
13. Nowill, W. K. Convulsions Following Pontocaine Spinal Anesthesia: Report of a Case. Anesthesiology 10:231–233, March, 1949.
14. Dwyer, C. S. Immediate Untoward Reactions To Spinal Anesthesia. Am. J. Surg. 81:172–177, Feb., 1951.
15. Bryce-Smith, R., Macintosh, R. R. Sixth Nerve Palsy After Lumbar Puncture and Spinal Analgesia, Brit. M. J. 1:275–276, Feb. 10, 1951.
16. Greene, B. A., Berkowitz, S., Goldsmith, M. The Prevention of Cranial Nerve Palsies Following Spinal Anesthesia. Anesthesiology 15:302–309, May, 1954.

PERIDURAL ANAESTHESIA FOR OBSTETRICS*

ANGUS MACMILLAN, M.D., C.M.**

THE administration of peridural anaesthesia is now accepted as a satisfactory procedure which is available to the experienced anaesthesiologist for caesarean section, and for all types of obstetrical delivery with the exception of internal version. When this method is to be used it is essential that the anaesthesiologist must have a prior knowledge of the technique of lumbar puncture and the anatomy of the areas surrounding the thoracic and lumbar spines, and must also have extensive experience in the use of spinal anaesthesia. It must be borne in mind at all times that the administration of peridural anaesthesia can lead to catastrophes to patients when it is attempted by casual, inexperienced, or careless anaesthesiologists.

Cathelin and Sicard (1) (1901) performed the first successful caudal blocks by injecting cocaine into the peridural space via the sacral hiatus. Sicard and Forrestier (1906) showed experimentally that it was feasible to make injections into the peridural space using the intraspinous approach. Lawen (1910) recommended the use of caudal block for perineal surgery: Kronig (1910) and Lundy (1935) produced a higher level of anaesthesia by increasing the amounts of anaesthetic solution injected into the caudal canal. Pagès (1921) first reported the use of peridural anaesthesia, and in 1931, Dogliotti (2) described a practical single injection technique.

In 1944 Tuohy (3) introduced his method of administering continuous spinal anaesthesia through a ureteral catheter. In 1949 Cleland, and Flowers, Hellman, and Hingson, described methods of using continuous catheter peridural anaesthesia for obstetrics.

The terms peridural, epidural, and extradural, are synonymous, (4) and the term caudal anaesthesia means that injection has been made into the same space through the sacral hiatus.

The statistical data presented is based upon 568 consecutive peridural anaesthetics which were administered in the case rooms of the Vancouver General Hospital.

PERIDURAL ANAESTHESIA		
Caesarean Section		29
Delivery—Vertex	525	
Breech	11	
Twins	3	
	—	539
Total Cases		568

*Presented at the Annual Meeting, Canadian Anaesthetists' Society, Vancouver, British Columbia, June 14, 1954.

**Department of Anesthesiology, Vancouver General Hospital and University of British Columbia.

Equipment available should include: a suitable tray; two draping towels and a hand towel; a medicine glass, sponges, antiseptic, and forceps; a 25 c.c., a 5 c.c., and a 2 c.c. syringe; a No. 18 G I.V. needle, a No. 24 hypodermic needle; and two No. 18 T G needles—one straight, and one with a huber point. Plastic tubing No. 442 T may be cut into lengths of approximately 36″, fitted with stillettes (which may be made from No. 5 or No. 6 tonsil wire), and sterilized separately for 5 minutes at 250°. With a catheter adapter this will provide a satisfactory catheter for the administration of continuous peridural anaesthesia.

FIGURE 1. Equipment tray.

The special bore needles (18 T) have been developed by Beckton, Dickinson and Company. Their large inner diameter will allow passage of No. 442 T plastic tubing, (which is also supplied by Beckton, Dickinson and Company), for the initiation of continuous catheter techniques, and will also simplify the method I shall describe, as pressure changes are much more apparent in a tube of large diameter than in one of small diameter.

Lidocaine Hydrochloride (Xylocaine) has proven to be the most suitable anaesthetic solution available at present. When used as a 2% aqueous solution it will produce anaesthesia for about 1¼ hours. If adrenaline 1:300,000 or 1:200,000 is added then the length of anaesthesia may be prolonged up to 2½ to 3 hours. As little adrenaline as possible should be used as it produces rigors in some patients. As a general rule it may be considered that 1–1½ c.c. of xylocaine will produce anaesthesia involving one segment, and that the maximum

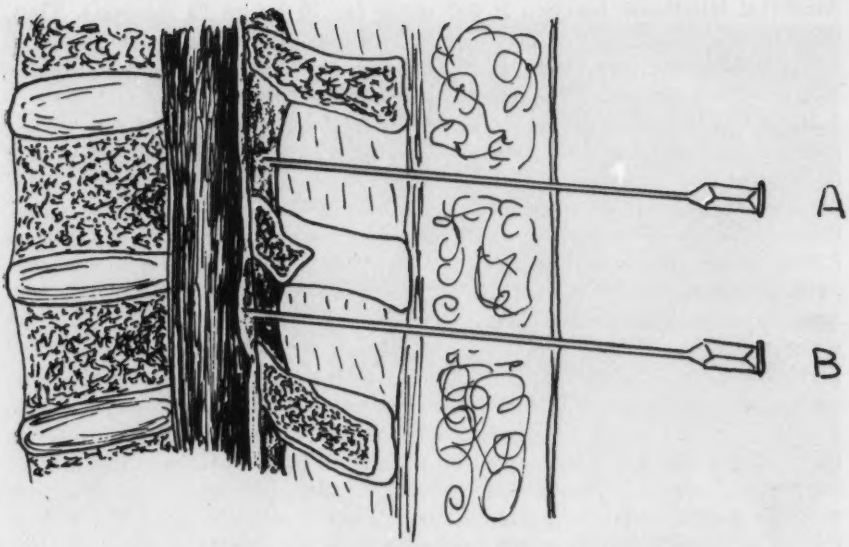


FIGURE 2. Technique.
A. Needle point in ligamentum flavum. B. Needle point in epidural space.

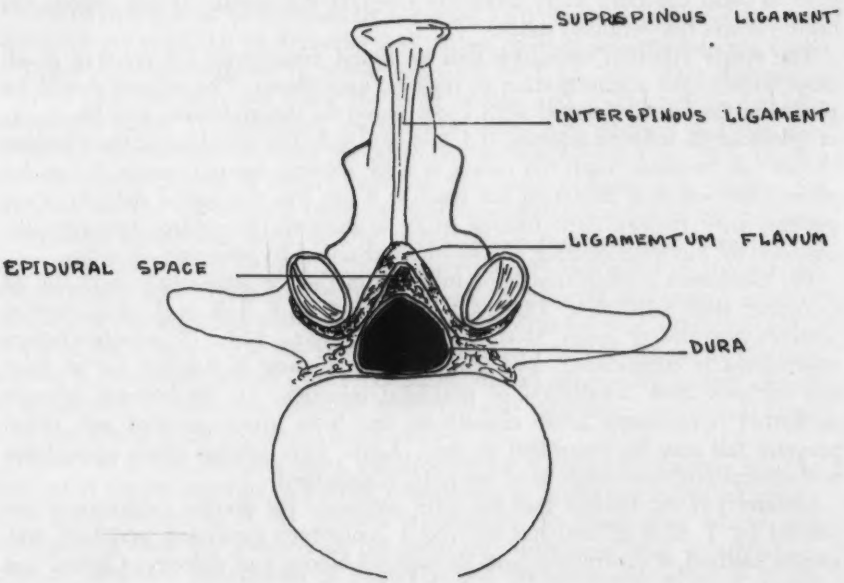


FIGURE 3. Cross section.

non-lethal intrathecal injection is 200 mgm. (or 10 c.c. of 2% solution). Thus, since the peridural space is filled mainly with fatty tissue and a venous plexus, the extent of anaesthesia obtained will depend upon the site at which the injection is made, and upon the quantity of drug injected.

Dogliotti's technique (2) is the most efficient for lower thoracic, and lumbar interspaces. A number 18–T needle is placed with its point in the substance of the ligamentum flavum. The stillette is removed and a 5 c.c. syringe containing anaesthetic solution is attached to the hub of the needle. It will be found that it is impossible to inject any solution into the strong and elastic ligamentum flavum. While constantly attempting to inject the solution the needle is slowly advanced through the ligament until it pierces the periosteal layer of the peridural space, and enters the space. Immediately, pressure on the plunger of the syringe will be released and the solution will be injected rapidly into the peridural space. The needle must be fixed in this position and a further test made: if a small syringe filled with air is attached to the hub of the needle it will be found that air can be injected into the peridural space with little or no resistance, and that no fluid can be withdrawn into the syringe. Injection of the required amount of anaesthetic solution can then be made, 5 c.c. at a time, and the needle withdrawn. This method depends entirely upon the sudden change of pressure which occurs as the point of the needle passes out of the substance of the ligamentum flavum, through the membranous periosteal layer of the peridural space and into the space itself. Thus it will be apparent that the needle which has the largest inside bore, and which is least traumatic, should be used, and also that forceful injection of solution into the space will tend to push the dura away from the point of the needle at the instant the needle enters the peridural space.

The single injection technique will be found satisfactory for delivery in all cases suitable for administration of regional anaesthesia. The patient should be placed in the lateral position with knees flexed on the abdomen, and 10–15 c.c. of xylocaine 2% solution injected at L 3–4 or L 4–5. For primiparae, the injection should not be made until the cervix is fully dilated; for multiparae it can be given when cervical dilatation has reached 8 cm. For the actual delivery some patients may require light nitrous oxide anaesthesia to control pressure discomfort. No vasopressor drug is administered unless hypotension develops.

For Caesarean Section the single injection method is satisfactory if 15 c.c. 2% xylocaine with adrenaline 1:200,000 is injected at L 1–2 or L 2–3. Section patients are always given Methedrine 15–20 mgm., I.M., 10 minutes before anaesthesia is commenced, and painting and draping is delayed for at least five minutes after completion of peridural injection. An intravenous infusion is started immediately after anaesthesia has been given, so that any blood pressure fall may be controlled at once. Again, light nitrous oxide anaesthesia will control any discomfort until the baby is delivered.

Cleland (5) established that the pain pathways for uterine contractions are carried by T 11 & 12 and has evolved a continuous combined peridural and caudal method of controlling pain throughout labour and delivery. Cleland has

FIGURE 4. Dogliotti's method: needle point in ligamentum flavum.

also used a double peridural method which has proven suitable for selected cases here—especially toxic cases, and those occasional cases in which satisfactory control of pain cannot be obtained by sedation. Two plastic catheters of the type described are used. An 18–T needle with huber point is inserted into the space at L 1–2 and one catheter is passed cephalad to T 12. The other catheter is inserted at L 3–4 or L 4–5, using the same needle, and is directed caudad into the caudal canal. The catheters are securely taped into position and the pain of uterine contractions can then be controlled by injecting 2–3 c.c. 2% xylocaine into the upper catheter at hourly intervals. The lower catheter is in position for use after cervical dilatation is complete and anaesthesia is required for delivery.

Peridural anaesthesia is especially advantageous for obstetrical patients. As this type of anaesthesia is essentially a paravertebral block affecting the anterior and posterior nerve roots in the peridural space, patients will retain most of their motor function and will be able to move as directed while they are being prepared for delivery. For the same reason previous C.N.S. disease is not considered a contraindication. Uterine contractions are frequently strong enough to accomplish spontaneous delivery. Vomiting and aspiration, post-spinal headache and neurological sequelae should vanish.

There are a few disadvantages which must be considered. Labour may be stopped if single injection peridural anaesthesia is given too early in labour, or in some multiparae if the position is posterior. In these cases labour will recommence when the anaesthesia has worn off. Multiparae may precipitate in spite of peridural anaesthesia if labour is too far advanced when it is administered. The incidence of forceps delivery is increased.

TABLE I

PERIDURAL ANAESTHESIA COMPLICATIONS (539 Deliveries)		
Type	Cases	%
Total Spinal	1	0.2
Inadvertent Lumbar Puncture	6	1.1
Failure (No Anaesthesia)	4	0.7
Labour Stopped	6	1.1
Patient Precipitated	3	0.5
Hypotension (Vasopressor Required)	24	4.4
Back Pain (Injection Site)	3	0.5
Transient Pains in Legs	3	0.5
Retained Placenta	6	1.1
Headache	1	0.2

Very serious technical difficulties may be encountered. These include inadvertent lumbar puncture with the possibility of injection of a large quantity of drug intrathecally: and drug reaction which must always be considered a possibility when any regional anaesthesia is used. Occasionally no anaesthesia may be obtained probably because injection has not been made into the peridural space. This is not a serious complication, but may prove embarrassing.

Peridural anaesthesia may now be administered safely by the experienced anaesthesiologist, and although it is technically more difficult to accomplish than other forms of anaesthesia available, those who will make the necessary effort to become proficient in its use will be amply rewarded by the favourable reaction of both patient and obstetrician.

SUMMARY

1. Peridural anaesthesia is especially advantageous for obstetrical patients. This report is based on its use in 568 such patients.

2. Various techniques for induction of peridural anaesthesia in obstetrical patients are outlined.

3. Peridural anaesthesia may be administered safely by the experienced anaesthesiologist, but should not be attempted by casual, inexperienced or careless practitioners of the art.

Résumé

L'anesthésie péridurale est acceptée maintenant comme procédure satisfaisante pour l'opération césarienne, et pour tous genres d'accouchement avec l'exception de la version interne. L'anesthésiste qui voudrait employer cette technique doit avoir une connaissance préliminaire de la technique de la ponction lombaire et de l'anatomie de la structure de l'épine thoracique et lombaire. En plus, il devrait posséder une expérience étendue dans l'emploi de l'anesthésie lombaire.

L'auteur rapporte l'emploi de l'anesthésie épidurale dans 568 cas obstétricaux à l'hôpital général de Vancouver et décrit ses techniques, employant l'injection unique aussi bien que les techniques de la sonde de Tuohy et Clelland. Les complications rencontrées ont été l'anesthésie lombaire totale, une ponction lombaire négligente, l'arrêt des douleurs, des douleurs précipités, l'hypotension, des douleurs de reins, des douleurs passagères dans les jambes, une rétention du placenta et des maux de tête. Dans quatre cas seulement l'anesthésie ne s'est pas produite.

La technique d'injection unique a été satisfaisante pour l'accouchement dans les cas de patients propres à l'anesthésie régionale, par l'emploi de 10 à 15 c.c. d'une solution d'xylocaïne à 2% injectée au L 3–4 ou au L 4–5. Pour la primipare on ne fera pas l'injection avant que le col de l'utérus ne soit complètement dilaté, mais pour la multipare l'on pourra procéder lorsque la dilatation aura atteint 8 c.m. Pour l'opération césarienne une injection unique de 10 à 15 c.c. d'xylocaïne à 2% contenant 1/200,000 d'adrénaline est effectuée au niveau du L 1–2 ou L 2–3.

Acknowledgments

Acknowledgments are made to Miss K. Hoskin for photography, and to Dr. J. G. P. Cleland, Dr. John J. Bonica, and Dr. M. Digby Leigh for instruction and encouragement.

REFERENCES

1. Ansbro, Latteri and Bodell. Continuous Segmental Thoracolumbar Epidural Block, Anes. & Analg. 32, 73, 1953.
2. Dogliotti, A. M. Segmental Peridural Spinal Anesthesia, Am. J. Surg. 20, 107, 1933.
3. Tuohy, E. B. Continuous Spinal Anesthesia, Surg. Clin. North Amer. 25, 834, 1945.
4. Bonica, John J. The Management of Pain, Lea & Febiger, 1953.
5. Cleland, J. G. P. Continuous Peridural and Caudal Anesthesia in Obstetrics, Anes. & Analg., 28, 61, 1949.

THE USE OF SHORT ACTING MUSCLE RELAXING DRUGS IN OBSTETRICAL ANAESTHESIA*

J. W. Dennis, M.D. and John J. Carroll, M.D.**

It is now over twelve years since Dr. Harold Griffith (1) first introduced the use of muscle relaxants into the field of anaesthesia. Since that time, they have been widely used and much has been written about them in relation to surgical anaesthesia. However, this is not the case regarding obstetrical anaesthesia, where the advantages of these drugs seem to have been overlooked by most anaesthetists.

Over the past three years the various members of our group have used muscle relaxants combined with light general anaesthesia for 591 deliveries.

The first muscle relaxant chosen for study was Syncurine or decamethonium bromide. This drug was chosen because of its effectiveness in producing good muscular relaxation and, compared to d-tubo-curare, for its relatively short action. Besides being the first relaxant studied, it has become with us the most popular one for obstetrical anaesthesia, for reasons we shall see later.

Syncurine has now been given to 451 obstetrical patients, of which approximately three-quarters were primiparae. The reason for the high proportion of primiparae is that these are the cases that usually present more difficulty at time of delivery, and are the ones where relaxation is more difficult to obtain.

In regard to the dosage used, in this series it has varied from one to five milligrams in a single injection. In some cases, such as in twin deliveries, we have given a second injection a short time after the first, and in this manner we have reached a total dosage of seven milligrams within a period of twenty minutes. Early in the series we tended to use smaller doses, such as two, and two and a half milligrams, but lately we seldom go below three and often use four or five milligrams.

The anaesthetic used is a mixture of nitrous oxide and oxygen given in approximately 75–25 concentration. We have found that by increasing the dosage of Syncurine to three milligrams or more, we are often able to carry the patient through the entire procedure, including the repair of the episiotomy, without resorting to a stronger agent such as cyclopropane. There seems to be a synergistic action between Syncurine and nitrous oxide which enables one to do this. We feel it is an advantage to be able to avoid using cyclopropane, as this drug is depressing to the baby if given for more than ten minutes before delivery. If we can avoid it the patients are also less likely to vomit, and this is much appreciated by them and commented upon when we visit them a day or two later.

The patients who received Syncurine can be divided into three groups:

1. The first group is composed of those cases where the baby is a vertex

*Presented at the Annual Meeting, Canadian Anaesthetists' Society, June 14, 1954.

**Department of Anaesthesia of Grace Hospital, Vancouver, B.C., and the Burnaby Hospital, Burnaby, B.C.

presentation and the obstetrician wishes to proceed with a forceps delivery. These patients, who have been receiving a mixture of 75% nitrous oxide and 25% oxygen with their pains, are then given the selected dose of Syncurine intravenously. In two or three minutes they will be completely relaxed and the obstetrician can proceed with the delivery. This group constitutes over 90% of the total cases.

2. The second group are the breech deliveries where the relaxant is given to facilitate delivery of the after-coming head. Here the injection of Syncurine must be timed very accurately to ensure that there is maximum relaxation at the time the head is being delivered.

3. The third group comprises those cases which are progressing very rapidly and where there is danger that the baby will precipitate. The relaxant stops all voluntary pushing by the mother, so the head can be delivered gradually, avoiding undue damage to either the baby's head or the mother's perineum.

Now let us consider the effect of Syncurine on the maternal respiration. There is usually an apnoea of four to eight minutes depending on the amount of Syncurine given. With smaller doses such as one or two milligrams, there may be merely respiratory depression, but with the larger doses there is usually an apnoea. The longest recorded in our series was eighteen minutes. During this time the patient is adequately oxygenated by manual compression of the breathing bag. It is most important that the mother receives a good supply of oxygen at all times. If the controlled respiration is carried on with extreme vigor the period of apnoea can be prolonged further.

The next and very important consideration is the effect on the baby. The fear that there would be placental transmission of the relaxant to the baby has made many people hesitate to use them in obstetrical cases. From this series it appears to be quite definite that Syncurine is not transmitted across the placenta in any effective concentration. In this series 94% of the babies required no resuscitation. Of the remainder, about half had an obvious cause for their difficulty, such as the umbilical cord being pulled tight about the baby's neck. Auscultation of the maternal abdomen in these cases often reveals a slow fetal heart rate prior to delivery. About 3% of babies required resuscitation for no apparent reason. This figure is extremely low, and we feel this amount of difficulty would be encountered in any similar series, regardless of anaesthetic agents.

The question of placental transmission of Syncurine is very interesting and various anaesthetists have held divergent views on this subject. Ellerker (2), writing in the British Medical Journal, felt that it did cross the placenta, although at a slower rate than d-tubo-curare, and that it caused depression in some babies. On the other hand, Organe (3), on the basis of his clinical experience, felt it was quite safe. Dr. Young (4) did some interesting experiments using Syncurine on pregnant rabbits and guinea pigs, wherein she definitely showed that the placenta was an effective barrier to the transmission of the Syncurine. The majority of those writing on Syncurine in recent years feel the placenta is a barrier to its transmission. We concur with this viewpoint.

Another advantage of Syncurine is that the obstetrician is nearly always able to deliver the placenta without delay. This would indicate there was no de-

pression of uterine tone by the Syncurine, and the uterus is able to respond to the injection of pitocin which is usually given immediately following the birth of the baby. This is attributed to the fact that the mother is being carried in a lighter plane of anaesthesia so that the uterine contractions are not slowed down as they would be by any of the more powerful agents such as ether or cyclopropane. In their article on this subject, Austin and Mering (5) state that Syncurine does not interfere with uterine contractions.

The incidence of episiotomies was not reduced greatly, as 72% of the cases required them. However, the size of the episiotomies was markedly reduced. In discussing this matter with the obstetricians, their impression was that they were often able to deliver the baby using a much smaller episiotomy than would otherwise have been required if a relaxant had not been used.

When the succinylcholine group of relaxants appeared we decided to give them a trial to learn if they had any advantages over Syncurine. To date we have used this group on 140 cases. The drugs studied were Anectine and Winthrop 7907, which are both the chloride, and Brevidil which is the bromide. All forms are equally satisfactory, but the dosage of the chloride and the bromide differ slightly in relation to the proportion of the active cation in the two compounds.

Of the 140 cases, only 37 were multiparae. Forceps were used in 80% of the cases. The succinylcholine relaxants were given in the same manner as that described for Syncurine and excellent relaxation was achieved.

There are some differences noted in this series as compared to the previous one:

1. The onset of relaxation is quicker than with Syncurine. Whereas with Syncurine it takes three or four minutes to get good relaxation, it only takes a minute with the succinylcholine group. This is useful when you require immediate relaxation as for the delivery of the head in breech presentations.

2. The period of relaxation and of maternal apnoea is shorter with the succinylcholine group. Most patients breathe adequately in three or four minutes, and this is distinctly advantageous where there is any difficulty with the resuscitation of the baby. We are also responsible for the resuscitation of the child, and so whatever measures are necessary can be instituted immediately.

3. If there is a large episiotomy, or if the obstetrician is slow with his repair, it is usually necessary to supplement the nitrous oxide with some more potent agent, such as cyclopropane or ether. These agents increase the incidence of vomiting. Therefore recovery is not as pleasant as when only Syncurine and nitrous oxide are required.

Again with this series of relaxants, resuscitation of the babies presented no difficulty. In only seven out of the 140 cases were moderate measures required, and in four of these there were obvious causes for the depression, such as an excess of opiate given to the mother, or a tight cord around the baby's neck. Only three of the 140 cases required moderate resuscitation where there was no apparent cause; this we feel is an acceptable percentage.

From this series it appears that the placenta is also an effective barrier to the passage of the succinylcholine group of relaxants. It may be that they are de-

toxified by the pseudo-cholinesterases in the mother's body before they reach the placenta.

The dosage in this series has ranged from 10 to 70 milligrams, with an average dose of 30 to 40 milligrams. Except for a few cases where very small doses were given, all the patients developed apnoea. As mentioned previously, the period of apnoea with this group of drugs is quite short, and lasts only two or three minutes. Assisted or controlled respiration was instituted wherever necessary to make certain the patient received an ample supply of oxygen at all times.

On the basis of this series of 591 deliveries we feel that the muscle relaxants offer advantages to all concerned. These are—

1. *Advantages to the baby.* By the addition of muscle relaxants much lighter general anaesthesia can be given to the mother and so the baby receives proportionately less anaesthetic and is less depressed. Also by having the muscles of the mother's perineum completely relaxed, much strain and trauma to the baby can be removed.

2. *Advantages to the mother.* With the complete muscular relaxation afforded by these drugs, smaller episiotomies have proved to be adequate and extension of episiotomies by tears have become infrequent. As a result less damage has been done to the perineum, and this is obvious at the time of the mother's six-week checkup. The decreased incidence of vomiting is much appreciated and is another advantage of this technique.

3. *Advantages to the obstetrician.* The completely relaxed musculature facilitates operative procedures and enables the obstetrician to deliver the baby deliberately and without trauma.

4. *Advantages to the anaesthetist.* Obstetrical patients are often poorly premedicated, and so are much more likely to develop complications such as excess salivation and laryngeal spasm. The addition of muscle relaxants tends to prevent such complications and makes the anaesthetic much smoother.

In conclusion we feel that muscle relaxants are a very definite asset in the field of obstetrical anaesthesia. They should not be used by untrained personnel, but in the hands of a trained anaesthetist they offer many advantages to the mother, baby and obstetrical team.

Summary

Decamethonium Bromide and Succinyl Choline have been used in combination with nitrous oxide anaesthesia to produce muscular relaxation for the vaginal delivery of 591 obstetrical patients. There has been no evidence of placental transmission of these drugs to the baby. The use of these drugs has made possible the employment of lighter general anaesthesia, smaller episiotomies, and control of precipitate delivery. Advantages have accrued to the baby, and the mother, and to the obstetrician and the anaesthetist.

Résumé

Le Bromide de Decamethonium et le Succinyl Choline ont été employés en combinaison avec l'anesthésie à l'oxyde nitreux pour produire le relâchement musculaire pour l'accouchement vaginal de 591 patients. Il n'y a pas eu in-

dication de transmission placentale de ces drogues au bébé. Ces drogues ont rendu possible l'emploi d'une anesthésie générale plus légère, des incisions plus légères de la vulve, et le contrôle des précipités d'accouchement. Les avantages ont augmentés en nombre pour le bébé, la mère, l'accoucheur et l'anesthésiste.

ACKNOWLEDGEMENTS

We wish to thank the other members of our group, Drs. P. B. Percheson, J. A. McNab and A. C. Blair, for their assistance in this work, and the obstetricians at Grace and Burnaby Hospitals for their co-operation in compiling this series. Thanks are also due Burroughs Wellcome, Poulenc, and Winthorp-Stearns, for their generous supply of the various drugs used.

REFERENCES

1. GRIFFITH, H. R. and JOHNSTON, G. E. The Use of Curare in General Anaesthesia—Anaesthesiology 3:418–420 (July) 1942.
2. ELLERKER, A. R. British Medical Journal 2:398 1950.
3. ORGANE, G. Lancet 1:773 1949.
4. YOUNG, M. Lancet 1:1052 1949.
5. AUSTIN, B. R. and MERING, T. W. American Journal of Obstetrics and Gynaecology, 62:143 1951.

HYDERGINE THERAPY OF UTERINE INERTIA*

P. B. Percheson, M.D., F.R.C.P.(C), and John J. Carroll, M.D.**

General Considerations

Normal labour is characterized by a co-ordinated pattern of uterine contractions and complete dilatation of the cervix within a reasonable length of time. *Caldeyro* and *Alvarez* (1) in their study of normal labour found that during a contraction the intra-uterine pressure ranged between 30 and 50 mm. of mercury. According to them, the intra-uterine pressure between contractions, i.e. the resting or basal tone of the uterus, was usually 8 to 12 mm. of mercury. Their uterine tracings and recordings showed that a normal contraction pattern started in the fundus and was of greater intensity in that region as compared to the lower segment. Thus the characteristic of normal labour, as demonstrated by these workers, is active participation of all parts of the uterus with strong synchronized contractions starting in the fundal region.

In contrast to this, primary uterine inertia is characterized by a prolonged and painful first stage of labour with incomplete dilatation of the cervix after 24 to 48 hours of ineffectual incoordinate contractions. Clinically, this state is apparent in patients who show signs of emotional tension and fear. In these cases, both the intensity of contractions and the resting tone of the uterus between contractions, may show a great deal of variation. Moreover, the contraction waves of fundal origin, and the normal gradient of activity from the upper to the lower segment are lacking. Instead, an abnormally weak or strong anti-peristaltic contraction pattern persists. These abnormal contractions are associated with slow and painful dilatation of the cervix. Labour becomes virtually arrested after a trying first stage and many of the patients become hysterical, uncooperative and difficult to manage.

MacRae (2) defined primary uterine inertia as a first stage of labour, which, in the absence of cephalo-pelvic disproportion has lasted 48 hours or more. He recognized six types. In his experience, the atonic uterus and the hypertonic uterus with cervical achalasia were the most common. He defined cervical achalasia as non-relaxation of the cervix despite continued severe contractions of the uterus. In his series, the condition was encountered in 3.2 percent of obstetrical cases and was more common in the emotionally hyperactive primipara. He stressed the high incidence of maternal morbidity and the high foetal loss. Asphyxia and intra-uterine infection were responsible for the foetal wastage in these cases.

Jeffcoate (3) considered the hypertonic type of inertia to be the more common and alluded to the functional aspect of this disturbance.

Arthur (4) encountered primary uterine inertia in 1.5 percent of his confinements. He correlated this disorder with disturbance of function, although he

*Presented at the Annual Meeting, Canadian Anaesthetists' Society, June 14, 1954.

**From the departments of Anaesthesia of the Vancouver Grace Hospital and the Burnaby General Hospital.

believed that the delay in dilatation of the 'hanging' cervix might be further complicated by excess fibrous tissue in that organ.

The records of *Caldeyro and Alvarez* (5) on abnormal labour support Jeffcoate's findings. They encountered the hypertonic type of inertia more frequently and found this type to be characterized by increased resting tone of the uterus, severe backache in the mother and hypoxia in the foetus. They described the contractions in this type of inertia as abnormal, irregular and of low intensity. Their uterine tracings showed a loss of fundal dominance of the contraction pattern and the majority of the contraction waves started in the lower segment and spread in an anti-peristaltic fashion to the upper segment. They showed that in this condition cervical dilatation did not progress.

On the other hand, *Williams* (6) claimed that the intra-uterine pressure of hypertonic uterine inertia varied a great deal. He showed that the uterine action was erratic and unpredictable and that there was a tendency for the organ to manifest tetanic spasm.

Reist (7) elaborated on the role played by sympatho-adrenal overactivity in the production of this disorder. He believed that emotional tension with its attendant sympatho-adrenal overactivity was also responsible for the syndrome which he described as 'fixation of the soft parts'. Clinically, this was manifested by a flaccid, relaxed and persistent anterior lip of cervix which had ceased to dilate. This lip often became incarcerated.

Reist (7) reminds us that the appearance of vaginismus on vaginal examination is an external manifestation of emotional tension and sympatho-adrenal overactivity. He points out that this syndrome consists of spasm of the vulvar introitus, internal rotation of the thighs and an attempt to withdraw from the obstetrician's examining hand. Morever, according to Reist, this same sympatho-adrenal overactivity is responsible for the various forms of primary uterine inertia and its attendant cervical spasm or 'fixation' of the cervix. Thus primary uterine inertia and external vaginismus are clinical manifestations of the same functional disorder.

Innervation of the Uterus

The anatomical sensory and motor innervation of the uterine fundus is located in the thoracic sympathetic fibres and the motor and sensory supply of the cervix is traced to the sacral parasympathetic system. This would imply that sympatho-adrenal overactivity must limit its effects to the uterine fundus as the cervix is supposed to be under purely parasympathetic control. The work of *Cleland* (8) and others refutes this implication. Cleland (8) showed that a paravertebral nerve block of the eleventh and twelfth thoracic segments completely abolished the pain of uterine contractions and cervical dilatation. Thus both uterus and cervix are subserved by the same sympathetic afferents whose pain fibres reach the cord with the eleventh and twelfth thoracic nerves.

Kaiser and *Harris* (9) demonstrated that in the pregnant female an injection of exogenous adrenalin will excite a spasm of both cervix and fundus and will disrupt the contraction pattern of normal labour. They noted that this disruption resembled the disordered contractions of uterine inertia in emotionally dis-

turbed patients. In these cases, endogenous adrenalin is believed to be secreted excessively.

Schofield (10) reported that stimulation of the hypogastric nerves in the rabbit excited contractions of both the cervix and the cornua. These effects could be reproduced by the injection of either adrenalin or noradrenalin.

Therefore, in summary, it appears that uterine inertia and cervical spasm is a functional disorder of the entire uterus. It is associated with emotional tension and sympatho-adrenal overactivity. The excess of endogenous adrenalin secretion exerts its effect on both cervix and fundus and results in a disorganized pattern of ineffectual contractions during labour. In this situation the first stage of labour is unduly prolonged and cervical dilatation does not progress. These factors are responsible for the high incidence of foetal asphyxia and maternal morbidity encountered in this condition.

Treatment

Many forms of therapy have been advocated for primary uterine inertia and cervical spasm. The conservative school have relied on rest, heavy sedation and intravenous fluids in the hope that these measures would result in a normal pattern of contractions and dilatation of the cervix. It is realized that rest and sedation are effective in allaying fear and apprehension and thus decrease the stream of central sympathetic impulses playing on the uterus and cervix. However, the prolongation of labour attendant upon this form of therapy is detrimental to both mother and child. Uterine anti-spasmodics such as papaverine have direct effect on smooth muscle, and thus suppress uterine contractions. Uterine stimulants such as pitocin are not without danger to both mother and child. Moreover, although the oxytocic property of pitocin does increase the intensity of the uterine contractions, it has no effect on the incoordinate character of the contraction pattern. (*Jeffcoate* (3).)

The reports of *Sauter* (11), *Gill* and *Farrar* (12) and *Baskin* and *Crealock* (13) on the use of dihydroergotamine (DHE) in primary uterine inertia and cervical spasm stimulated our interest in the hydrogenated ergot alkaloids. *Rothlin* (14) showed that in animals DHE had no oxytocic action. His experiments demonstrated that hydrogenation of the ergot molecule either completely abolished or markedly suppressed its oxytocic properties and, at the same time, greatly enhanced its latent adrenolytic and sympatholytic actions. We (15) used DHE in a series of 50 cases and obtained good results. However, it was our impression that the drug did have a mild but definite oxytocic action when administered intravenously in effectual dosages. Although there were no maternal or foetal complications attributable to the drug, the slowing of the foetal heart in 60 percent of the cases did cause us some concern.

For this reason, we have supplanted DHE with Hydergine in a recent series of 100 cases. Hydergine is an equiproportional mixture of dihydroergocornine, dihyrdoergocristine and dihydroergokryptine, derivatives of the three alkaloids comprising the ergotoxine group. It is marketed in 1 ml. ampoules containing 0.3 mg. of the alkaloidal mixture. Hydergine has a central action on the vasomotor center which results in a vasodilatation and a lowering of the vascular

tone in the peripheral vessels. It also has a central vagal stimulating action, and thus, a slow pulse rate is characteristic of Hydergine therapy. Peripherally it exerts an adrenolytic and sympatholytic action and in this way it resembles DHE. However, Hydergine has an additional direct action on the smooth muscle of the peripheral vessels which results in vasodilatation. In this way, it differs from DHE which exerts a mild vasoconstricting action directly on the smooth muscle of these vessels. Hydergine is recommended for the treatment of peripheral vascular disease and hypertension whereas, DHE is recommended for the treatment of migraine cephalalgia.

Rothlin (14) showed that hydrogenation of ergot alkaloids either completely abolished or markedly suppressed their oxytocic action. Because of the difference in the direct smooth muscle effect between the two drugs, we believe that the oxytocic action was more thoroughly eliminated in the case of Hydergine. In addition, it has been shown experimentally that the adrenergic blocking action of Hydergine is more profound on the blood vessels of visceral organs as compared to the somatic. Small doses of Hydergine which readily block the vasoconstrictor action of epinephrine on the renal and superior mesenteric beds do not significantly alter the femoral blood flow response to intra-arterial epinephrine. (*Gruhzit* (16).)

The indication for the use of Hydergine was clinical evidence of arrested labour in a tense, emotionally hyperactive patient who showed no obvious cephalo-pelvic disproportion. In a large number of our cases, the tension mounted to a pitch of hysterical screaming. These patients performed writhing movements during the contractions and complained of great discomfort between their pains. The actual contractions were noted to be of poor quality and character and unduly painful. Dilatation of the cervix did not progress in these patients and vaginal examination usually revealed a hard tense cervix which had reached the stage of 6 cm. or more of dilatation. Occasionally, the obstetrician reported a soft hanging lip of cervix which on repeated vaginal examination showed no change or progress. A few of the cases were outwardly calm and co-operative but their covert tension was revealed by the manifestation of marked vaginismus to vaginal examination.

The drug was used in various dilutions. Fifty of the cases received the Hydergine in a dilution of 1 ampoule in 10 ml. of water; sixteen in a dilution of 1 ampoule in 5 ml. of water; twenty-six in a dilution of 1 ampoule of Hydergine in 500 ml. of 5 percent glucose solution; five in a dilution of 1 ampoule in 20 ml. of water, and the remaining three patients had the drug administered in a dilution of 1 ampoule in 1000 ml. of 5 percent glucose solution. The drug was administered slowly over a period of 5 to 8 minutes in the patients receiving the 1 in 5 to 1 in 20 dilutions. A drip rate of from 60 to 120 drops per minute was used for the 1 in 500 to 1 in 1000 dilutions and the infusion was stopped as soon as the desired effect was obtained. All the patients received the drug intravenously.

There were 100 cases in the Hydergine series. In 64 percent of these, the cervix dilated fully within 20 minutes from the time the Hydergine injection was started. Furthermore, the majority of the cases in this group, 37 to be exact,

were fully dilated within 10 minutes. Of these there were 54 multiparas whose average duration of labour before Hydergine therapy had been 13 hours—(the shortest was 4 and the longest 30 hours). Ten of the patients were primiparas whose average duration of labour had been 25 hours—(the shortest was 17 and the longest was over 48 hours). It is significant that there was external evidence of tension and emotional overactivity in approximately four-fifths of this group where the response to Hydergine therapy was dramatic. Moreover, there were 7 posterior presentations in this group. Of the remaining 36 percent of the Hydergine series, 19 became fully dilated within 1 hour following the drug administration and the other 17 patients required anywhere from 80 minutes to 5 hours. However in these 36 cases where the results were considered to be equivocal, there were 10 posterior presentations, 4 cephalo-pelvic disproportions and 4 cases where the drug was tried in an attempt to expedite a normally progressing labour. It is again significant that in over two-thirds of these patients there was no evidence of emotional overactivity. Therefore, this 36 percent of the Hydergine series did not fulfill the criteria which, in retrospect, we considered necessary for successful Hydergine therapy.

Complications

There were four instances where the foetal heart slowed to between 80 and 90 beats per minute. In one instance there was a spasm of the uterus for the duration of two pains. In this case the foetal heart rate slowed to 90. This may have been a coincidence because *Williams* (6) found that there was a tendency for uterine spasm to occur in the hypertonic type of inertia.

There were no foetal deaths or maternal complications which could be ascribed to the use of Hydergine. The drug had no appreciable effect on the maternal blood pressure. The absence of maternal hypotension was probably due to two factors:—(1) recumbency of the patients, (2) the tendency for Hydergine to exert a more profound effect on the visceral vascular bed as compared to the somatic (16).

Discussion

We were impressed with the relative safety of Hydergine as compared to DHE and Pitocin. The beneficial effect of this therapy was most evident in the primary uterine inertia of the hypertonic type. The clinical criteria for the successful administration of Hydergine were: (1) evidence of emotional overactivity, (2) evidence of arrested labour in the course of trying first stage, (3) evidence that cervical dilatation had progressed to at least 6 cm., (4) evidence of either non relaxation of the cervical os despite hard pains, or of a persistent, soft anterior lip of cervix, (5) absence of definite cephalo-pelvic disproportion. In 64 percent of our series, where the results were good, the majority of the patients fulfilled these criteria. The cephalo-pelvic disproportion was probably minimal in the 7 posterior presentations which responded rapidly to Hydergine.

Some patients were apparently calm and co-operative but the progress of their labour manifested all the other criteria of primary uterine inertia. These cases were better able to suppress the external component of sympatho-adrenal

overactivity. However, the presence of vaginismus on vaginal examination revealed their covert tension and their response to Hydergine therapy was also good. Because one case of mild uterine spasm was encountered when the drug was used in a dilution of 1 ampoule (0.3 mg.) of Hydergine in 10 ml. of water, we feel that the more dilute solutions of the drug such as 1 ampoule in 500 ml. of 5% glucose solution are indicated.

In the 36 percent of our series where the results of Hydergine therapy were considered either equivocal or poor, there was a high incidence of complicating factors such as disproportions and posterior presentations. Furthermore, the majority of this group did not show any clinical evidence of emotional tension.

Summary and Conclusions

HYDERGINE THERAPY OF 100 CASES OF UTERINE INERTIA	
A. 64% EXCELLENT RESULTS	cervix fully dilated within 20 minutes.
BREAKDOWN	
(1) 37 of the 64 dilated in 10 minutes.	
(2) Four-fifths of the 64% showed evidence of emotional overactivity.	
B. 36% EQUIVOCAL RESULTS	cervix fully dilated in from 1 to 5 hours.
BREAKDOWN	
(1) 19 dilated in 1 hour.	
(2) 17 dilated in from 80 minutes to 5 hours.	
(3) Two-thirds of the 36% showed NO clinical evidence of emotional overactivity.	
(4) 14 cases showed definite evidence of cephalo-pelvic disproportion.	

One hundred obstetrical patients were treated with Hydergine. The drug was used intravenously in various dilutions. In 64 percent of the cases the results obtained were dramatic. In the remaining 36 percent the poor results were attributed to: (1) the high incidence of complicating factors, (2) the random selection of the earlier cases.

The one case of uterine spasm may have been a coincidence. However, because of this, we have resorted to the use of intravenous drip infusion of a solution of 1 ampoule of Hydergine diluted in 500 ml. of 5% glucose solution.

Hydergine should be reserved for patients who manifest all of the clinical criteria of primary uterine inertia and cervical spasm. We feel that definite evidence of cephalo-pelvic disproportion is a contra-indication for this therapy. In our experience the drug is of no value in expediting normal labour.

We are not prepared to say whether the sympatholytic and adrenolytic actions of Hydergine produce their effects predominantly on the cervix or on the entire uterus. Whatever and wherever its mode of action, the net result is a more efficient type of uterine contraction and rapid dilatation of the cervix. With this accomplished, the foetal wastage and the maternal morbidity in these difficult and trying labours is materially reduced.

We are indebted to our colleagues, Drs. A. C. Blair, J. A. McNab and J. W. Dennis for their advice and material contributions in the preparation of this series. We wish to acknowledge the support and cooperation of the obstetricians of the Vancouver Grace Hospital and the Burnaby General Hospital. We are grateful to Sandoz Pharmaceuticals for their generous supply of Hydergine.

Resumé et Conclusions

Thérapeutique avec Hydergine de 100 cas d'inertie Utérine		
A. 64%	Résultats Excellents	le col de l'utérus complètement dilaté en 20 minutes.
	Détails	
	(1) 37 des 64 dilatés en 10 minutes.	
	(2) 4/5ième des 64% ont montré évidence d'un excès d'activité émotionnelle.	
B. 36%	Résultats Equivoques	le col de l'utérus dilaté dans un espace variant de 1 à 5 heures.
	Détails	
	(1) 19 dilatés en 1 heure.	
	(2) 17 dilatés dans un espace variant de 80 minutes à 5 heures.	
	(3) 2/3 des 36% n'ont pas révélé une évidence clinique d'un excès d'activité émotionnelle.	
	(4) 14 cas ont révélé une évidence nette de disproportion céphalo-pelvienne.	

Cent cas obstétricaux ont reçu le traitement à l'Hydergine. La drogue en solutions variées a été employée par injections intraveineuses. Dans 64% des

cas les résultats obtenus ont été frappants. Dans les autres 36% les résultats médiocres ont été attribués à (1) l'incidence élevée de facteurs amenant des complications, (2) aux choix au hasard des cas précédents.

Il se peut que le seul cas de spasme utérin ait été une coïncidence. A cause de ceci, toutefois, nous avons eu recours à l'infusion intraveineuse goutte à goutte d'une solution contenant une ampoule d'Hydergine diluée dans une solution de 500 ml. de glucose à 5%.

On devrait réserver l'hydergine pour les patients qui manifestent tous les critères cliniques de l'inertie utérine primaire et du spasme utérin. Nous sommes d'opinion que l'évidence nette de disproportion céphalo-pelvienne est une contre-indication pour ce traitement. Suivant notre expérience la drogue n'a aucune valeur pour accélérer les douleurs qui accompagnent l'accouchement.

Nous ne savons pas encore si les actions sympatholytiques et adrénolytiques produisent leurs effects principalement sur le col de l'utérus ou sur tout l'utérus. Quelle que soit et où que soit son mode d'action, le résultat net est un genre plus efficace de contraction utérine et une dilatation plus rapide de l'utérus. Ces conditions présentes, les déchets foetaux et la morbidité chez la mère, pendant des accouchements difficiles et pénibles, sont considérablement réduits.

REFERENCES

1. Caldeyro Barcia, R. and Alvarez, H. J. Obst. & Gynaec., *59*, 617, (1952).
2. MacRae, D. J. J. Obst. & Gynaec., *56*, 785, (1949).
3. Jeffcoate, T. N. A. J. Obst. & Gynaec., *59*, 658, (1952).
4. Arthur, H. R. J. Obst. & Gynaec., *56*, 983, (1949).
5. Caldeyro Barcia, R., and Alvarez, H. J. Obst. & Gynaec., *59*, 646 (1952).
6. Williams, A. E. J. Obst. & Gynaec., *59*, 636, (1952).
7. Reist, A. Schweiz. Med. Jahrb., p. 41, (1949).
8. Cleland, J. G. P. Current Researches in Anest. & Analg., *31*, 289 (1952).
9. Kaiser, I. H., and Harris, J. S. Am. J. Obst. & Gynec., *59*, 775, (1950).
10. Schofield, Brenda M. J. Physiol., *117*, 317, (1952).
11. Sauter, H. Schweiz. med. Wchnschr., *78*, 512, (1948)—Schweiz. med Wchnschr., *78*, 475, (1948).
12. Gill, Robert C., and Farrar, James M. J. Obst. & Gynaec., *58*, 79, (1951).
13. Baskin, M. J., and Crealock, F. W. West. J. Surg., *58*, 302, (1950).
14. Rothlin, E. Bull. Acad. Suisse Sci. Med., *2*, 249, (1946–47).
15. Percheson, P. B., and Carroll, J. J. Proc. Can. Anaesth. Soc., *2*, 112, (1953).
16. Gruhzit, C. C., and Moe, G. K. (Department of Physiol., State Univ., N.Y.) to be published in J. Pharmacol. & Exper. Therap.

A STUDY OF THE VALUE OF DIMENHYDRINATE AND PROMETHAZINE HYDROCHLORIDE IN THE CONTROL OF POST-ANAESTHETIC VOMITING*

R. A. GORDON, M.D., F.R.C.P.(C), F.F.A.R.C.S.,
S. L. VANDEWATER, M.D., F.R.C.P.(C),
G. E. SLEATH, B.A., M.D., AND DOREEN CAPLIN, M.D.**

THE occurrence of vomiting in the post-operative period has been one of the most constantly observed complications of the anaesthetic era. This complication is usually simply annoying and unpleasant, although occasionally the patient may in this manner lose sufficient fluid and electrolyte to prejudice his recovery. Many of the causes remain obscure and it has been for generations the hope of anaesthetists, surgeons and patients alike that this complication of the post-operative period might be eliminated, or abated. Each new anaesthetic agent and technique has been carefully evaluated for its influence in this respect. Despite all such research and evaluation, vomiting has remained a common and unpleasant feature of the post-operative period in a significant proportion of surgical patients.

Lee (1) states that vomiting may be influenced by one or more of the following factors: (a) anaesthetic agent and technique (b) type of patient (c) condition of the stomach (d) morphine (e) type of operation and (f) sex. Davis (2) found that nitrous oxide, oxygen and ether combination produced the highest incidence of post-operative vomiting, but the preliminary addition of 5% Pentothal reduced the incidence by almost 20%. The addition of cyclopropane to the anaesthetic sequence appeared to have little effect on the vomiting rate. In minor gynaecological procedures, all including dilatation of the cervix, he reports 64% vomited. Concerning sex incidence, the ratio with gas/oxygen/ether was 68.6 females to 45.5 males. Smith (3) concluded that the duration of anaesthesia was a definite factor in the amount of constitutional upset, and suggested that it may be due to production of slight degrees of anoxia by surgical shock; but he found the incidence of vomiting in children did not appear to be significantly altered by duration of anaesthesia.

The mechanism of vomiting involves the coordinated actions of the muscles of the stomach, oesophagus, and abdominal wall. The act may also be associated with anti-peristaltic movements in the intestine (4). According to Barclay (5) just prior to the commencement of vomiting movements a sudden reduction of gastric tone occurs, coinciding with the sensation of nausea. The muscular mechanisms are governed by a centre in the medulla, situated in the neighborhood of the dorsal nucleus of the vagus, close to but quite distinct from the respiratory centre. The centre is stimulated by mechanical or chemical irritants

*Presented at the Annual Meeting, Canadian Anaesthetists' Society, at Vancouver, British Columbia, June 14, 1954.

**From the Department of Anaesthesia, Faculty of Medicine, University of Toronto.

acting upon vagal or sympathetic afferent terminals, by certain substances such as apomorphine, emetine and picrotoxin which directly raise the excitability of the tissue, and by elevation of intracranial pressure or anaemia which raise excitability through interference with blood supply. It seems logical to assume that vomiting can be prevented by avoiding stimulating substances, or by depression of the vomiting centre.

Prophylactic measures to reduce post-operative nausea and vomiting are outlined by Hewer (6) as the following: (a) suitable preparation—no solid contents in the stomach, (b) glucose 24 hours pre-operatively, and in an enema post-operatively, (c) post-operative insulin (usually 10 units) in addition to the glucose if a considerable amount of ether has been used, (d) a basal narcotic or induction with intravenous barbiturate, (e) the use of minimal quantities of toxic drugs such as ether and chloroform, (f) hyperventilation for a short time with carbon-dioxide after long operations using much ether, (g) elimination to a large extent of the pyschic factor by suitable suggestion during the induction, and (h) earlier post-operative feeding, but avoiding milk, orange juice, or fats.

The use of Insulin was first reported by Minnit (7), who showed that post-anaesthetic toxic symptoms and acetonuria were associated with a high blood sugar, and that control of the latter by insulin relieved the nausea and vomiting. Smith (8) corroborated Minnit's work, but widespread use of insulin post-operatively has not been reported.

In 1947, Bergmann (9) reported a series of 12 cases to whom 100 mgm. of pyridoxine was given pre-operatively and one hour post-operatively, with no vomiting and only slight nausea. More recent work by Kernis and Stodsky (10) and by Hill (11) has failed to confirm his findings.

In 1947 Gay and Carliner (12) administered dimenhydrinate to a pregnant woman who complained of urticaria, and who incidentally had suffered all her life from car sickness. Unexpectedly the car sickness was relieved as well as the urticaria. In 1948 they carried out extensive studies on the effect of dimenhydrinate on seasickness, and reported favourably on it. Carliner *et al.* (13) extended its use to nausea and vomiting of pregnancy, Beeler *et al.* (14) to radiation sickness, and Campbell (15) to the treatment of vestibular reactions following the labyrinthine fenestration operation.

Paterson (16) in 1949 used dimenhydrinate for post-operative vomiting. He dissolved 100 mgm. of the drug in 30 c.c. of water, and administered it per rectum with the advent of post-operative nausea and vomiting. It was found that rarely more than one administration was necessary, and relief was obtained in 20 or 30 minutes. Rudolph (17) gave 100 mgm. orally one half hour pre-operatively. In cases with post-operative nausea and vomiting he used 100 mgm. suspended in 20 c.c. of isotonic sodium chloride, and given rectally. He reports excellent results on 22 cases. Wolfe (20) compared the incidence of nausea and vomiting in a series of 143 patients given dimenhydrinate before and after operation with the incidence in a control series of 139 patients, and concluded that dimenhydrinate reduced post-operative nausea and vomiting, but that the reduction was not great enough to warrant its routine use on a general surgical service.

The use of promethazine hydrochloride as an anti-nauseant and anti-emetic has been recorded in the literature by a number of authors since 1948 (21) (22), (23), (24). These reports refer to its use in the control of motion sickness, the nausea and vomiting of pregnancy, and drug reactions.

The present study was undertaken to determine the efficacy of dimenhydrinate and of promethazine hydrochloride (dibenzoparathiazine) in the control of post-operative nausea and vomiting. (In each case the doses used were those recommended for the purpose by the manufacturers of the drugs, at the time when the study was undertaken.) Promethazine HCl is marketed by Poulenc Limited under the trade-name "Phenergan", and Dimenhydrinate by F. W. Horner & Co. as "Gravol" and by the G. D. Searle Co. as "Dramamine".

Methods

In the initial phases of this study, dimenhydrinate was administered one hour pre-operatively in the form of a rectal suppository containing 100 mgm. of "Gravol" in a suitable base. These patients were compared with a similar series who received no suppository. In the second phase dimenhydrinate was administered by the intramuscular route in doses of 50 mgm. pre-operatively, followed by 25 mgm. every four hours post-operatively for four doses. Promethazine HCl was used by intramuscular injection of 50 mgm. pre-operatively or at operation, followed by 50 mgm. intra-muscularly q.4.h. for two doses post-operatively. Both injection series were compared with a similar number of patients who received a similar injection of normal saline from an ampoule identical with the Phenergan ampoule and labelled "Phenergan Control", neither the nurses or the patients being aware that the control ampoules had been substituted for the Phenergan. In addition, 100 obstetrical patients were given a single intra-muscular injection of Promethazine HCl 50 mgm. on admission to the delivery room, and the incidence of vomiting and infant depression in these patients was compared with that in 100 patients who received a similar injection of saline from ampoules of "Phenergan Control", and with a like number who received no injection.

Some selection of cases was used. To eliminate the factor of gastric contents, no emergency procedures are included in the series except in the case of the obstetrical patients. No spinal anaesthetics are included in the series, and patients who had duodenal tubes for post-operative drainage were eliminated.

In the series of patients who received dimenhydrinate in a rectal suppository patients having rectal or vaginal operations were excluded. In this series, too, twelve patients who did not receive pre-operative enemas are excluded from the analysis because of the possibility of impaired absorption from a full rectum, while 6 patients who received suppositories and 6 of the control series are excluded because they did not receive morphine in the pre-operative preparation.

For the purposes of this report vomiting only is recorded, since this is an objective phenomenon which can be accurately recorded by an observer. In the patients who had rectal suppositories the patients were questioned about nausea and vomiting, and nursing notes were checked, although these were found generally to be incomplete. The control series for this portion of the investigation

was checked in the same way. As pointed out by Hill (11), this method of follow-up is not ideal, for discomfort experienced during the first 6 hours or so after recovering from anaesthesia is often forgotten by patients, and is not forthcoming on routine questioning. In the injection series special records of vomiting were maintained by the nursing staff, and any record which was found to be incomplete was rejected.

In the dimenhydrinate suppository series all patients had morphia and atrophine as pre-operative medication. In the subsequent series no selection of cases was made on this basis, although the usual pre-operative sedative was morphia gr. ⅛ or gr. ¼ with atrophine gr. 1/150, given 45 minutes pre-operatively.

No differentiation is made between general anaesthetic agents in this report. The patients were anaesthetized with ether, cyclopropane, nitrous oxide combined with pentothal or trichlorethylene, with the frequent addition of various relaxant drugs.

Results

1. *Dimenhydrinate*

A. *Suppositories*

The effect of the routine use of dimenhydrinate suppositories as a pre-operative measure for the control of vomiting under the conditions outlined above is shewn in Table I.

TABLE I

	No vomiting		Vomited		Total	
	Number	%	Number	%	Number	%
"Gravol" Suppository (100 mgm.)	47	56.7%	36	43.3%	83	100%
Control	39	41.5%	55	58.5%	94	100%
Difference		15.2%				
Standard Error of difference = 7.44%			2 × S.E. = 14.9%			

B. *Injection*

The effect of dimenhydrinate given parenterally on post-operative vomiting is shewn in Table II. Fifty milligrams of the drug was injected either intramuscularly (70 cases) or intravenously (24 cases) at the time of operation, and 50 mgm. intramuscularly every four hours for four doses post-operatively.

2. *Promethazine HCl*

The effect of post-operative vomiting of promethazine HCl given routinely to general surgical patients is shewn in Table III. Fifty milligrams was given intramuscularly during operation, and twenty-five milligrams every four hours for four doses post-operatively.

TABLE II

	No vomiting		Vomited		Total	
	Number	%	Number	%	Number	%
Dimenhydrinate 50 mgm. I. Musc. or I.V. during operation. 50 mgm. q.4.h. x 4 I. Musc. after operation.	69	73.4%	25	26.6%	94	100%
Control (Injection of saline from ampoules.	35	58.4%	25	41.6%	60	100%
Difference		15%		15%		
Standard Error of difference = 7.83%			2 × S.E. = 15.61%			

TABLE III

PROMETHAZINE General surgery	No vomiting		Vomiting		Total	
	Cases	%	Cases	%	Cases	%
Promethazine HCl —50 mgm. at operation —25 mgm. q.4.h.x 4	58	89.3%	7	10.72%	65	100%
"Control"— Injection of Physiological saline from ampoules	35	58.4%	25	41.6%	60	100%
Difference		30.9%		30.9%		
Standard Error of difference = 7.43%			2 × S.E. = 14.8%			

The effect on post-partum vomiting of a single dose of 50 mgm. of Promethazine HCl given to unselected obstetrical patients is shewn in Table IV. The effect of the drug on the response of the infant is also assessed.

Discussion

The difficulty of assuring accurate recording in a study such as this in a busy General Hospital has been mentioned above. We have attempted to overcome inaccuracy in this respect by rejecting all records in which there appeared to be some doubt of completeness or accuracy. While this has greatly reduced the total number of cases included in the analysis we feel that the gain in accuracy outweighs the statistical disadvantage of the shorter series.

TABLE IV

Promethazine Obstetrical Patients	Mother						Infant					
	Vomited		No vomiting		Total		Depression		O_2		Intubated	
	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
Phenergan 50 mgm. before delivery 100 patients	20	20%	80	80%	100	100%	28	28%	19	19%	8	8%
"Phenergan Control" (Saline) 100 patients	35	35%	65	65%	100	100%	21	21%	19	19%	8	8%
No Injection (100 patients)	32	32%	68	68%	100	100%	10	10%	9	9%	5	5%
Difference between Promethazine and Control		15%		15%				7%		0		0
Standard Error of difference = 6.2% (Vomiting)						2 × S.E. = 12.4%						

In judging the significance of differences in incidence of vomiting between the patients receiving the drugs and the controls we have followed the recommendation of Campbell (25) that a significant difference must be at least twice the standard error of the difference between the percentage figures for the two series. It is seen, therefore, that the difference in vomiting following the routine use of a suppository containing 100 mgm. of Dimenhydrinate may be significant (Table I). The difference between those patients receiving Dimenhydrinate by injection in the doses used and those receiving injections of saline is on the border-line of significance (Table II), while the reduction of vomiting by Promethazine HCl in the doses used in this study is statistically significant (Table III, Table IV). It is evident, too, that Promethazine HCl produced no foetal depression when given in doses of 50 mgm. intramuscularly to obstetrical patients.

During the period of this study we made several interesting observations relating to the influence of psychic factors, including personal opinion, on the conduct of such a clinical research problem. It will be evident from a study of Table III that the vomiting rate was very low during the period of routine administration of promethazine hydrochloride by injection. We are of the opinion that it was probably less than the records show, since there appeared to be a tendency for the nurse to record vomiting when it occurred, and to forget to complete the record when there was no vomiting. When the control

ampoules of saline were substituted for those of promethazine hydrochloride on the surgical service used for this study the vomiting rate increased suddenly, and for the first time the surgical and anaesthetic internes became aware that the patients were receiving routinely an injection of an "experimental" substance. This substance (saline control) was promptly credited with the production of vomiting, and we were firmly requested to cease its administration.

During the study of the effect on the infant of Promethazine HCl given to the mother, the obstetrical internes who were responsible for the decision as to whether the infant was or was not depressed had decided that the substance was producing foetal depression. It is evident from comparison of the promethazine series and the saline control series in Table IV that this was not true, and the considerable drop in the infant depression rate when no injection was given probably represents the effect of this personal opinion.

Conclusions

From this study we have drawn the following conclusions.

1. The administration of Dimenhydrinate in a rectal suppository appears to reduce post-operative vomiting, but this form of dosage is cumbersome and is not considered suitable for routine use on a surgical service.

2. The routine parenteral administration of dimenhydrinate during operation and in the post-operative period under the conditions of this study appeared to reduce post-operative vomiting, but the statistical significance of the results obtained in this study is questionable, and we do not feel that the results justify the routine use of this substance as a prophylactic measure against post-operative vomiting on a surgical service.

3. The routine parenteral administration of Promethazine HCl under the conditions of this study produced a very significant reduction in the incidence of post-operative vomiting in general surgical patients, and in obstetrical patients, without evidence of foetal depression in the latter, and we believe that this substance may warrant routine use in such patients for the control of vomiting.

Summary

The routine use of Dimenhydrinate ("Gravol", "Dramamine") and of Promethazine HCl ("Phenergan") in the prevention of post-operative vomiting has been studied, using the drugs according to the dosage scale recommended by the manufacturers at the time this study was undertaken. The incidence of vomiting in these patients was compared with suitable control groups who did not receive the drug. Dimenhydrinate was given to surgical patients only, while Promethazine HCl was also tested in a single dose series on obstetrical patients. In the obstetrical group it was demonstrated that in the dosage used Promethazine HCl did not depress the infant.

It is concluded that while Dimenhydrinate appears to suppress post-operative vomiting to some extent, the results in this study do not have sufficient statistical significance to warrant its use as a routine measure on a surgical service. Promethazine HCl produced a very significant reduction in vomiting under the con-

ditions of this study, and probably warrants further use as a prophylactic measure against post-operative vomiting.

ACKNOWLEDGEMENTS

We wish to express our appreciation to Professor D. E. Cannel, Professor of Obstetrics and Gynecology, University of Toronto and Dr. F. G. Kergin, Chief of Surgical Service, Ward B, Toronto General Hospital, whose cooperation made this study possible. We wish also to acknowledge our indebtedness to Miss Lois Peacock, R.N., and the nursing staff of Ward B, Toronto General Hospital, and to Miss Jean Lawson, R.N., of the Burnside Division, Toronto General Hospital, for their generous assistance in administering the drugs and maintaining the records.

The Dimenhydrinate used in this study was generously supplied by F. W. Horner & Co. in the form of "Gravol" suppositories and "Gravol" Injectable, and by G. D. Searle & Co., as injectable "Dramamine." The Promethazine HCl was supplied in the form of injectable "Phenergan" by Poulenc, Ltd., and we are also indebted to this house for providing us with control ampoules of saline labelled "Phenergan Control".

RÉSUMÉ

L'emploi régulier du Dimenhydrinate ("Gravol", "Dramamine") et du Prométhazine HCl ("Phenergan") pour la prévention du vomissement après l'opération a été étudié en employant les drogues selon l'échelle de dosages recommandée par les fabricants au moment où cette étude a été entreprise. L'incidence du vomissement de ces patients a été comparé à celui de groupes appropriés de contrôle qui n'ont pas reçu la drogue. Le Dimenhydrinate a été administré seulement à des cas chirurgicaux, tandis que le Prométhazine HCl a aussi été éprouvé en séries de dose unique, dans des cas obstétricaux. Dans le groupe obstétrical on a démontré que, suivant le dosage employé le Prométhazine HCl n'a pas amené une dépression chez l'enfant.

La conclusion est la suivante. Quoique le Dimenhydrinate semble supprimer à un certain degré le vomissement après l'opération, les résultats de cette étude n'ont pas une signification statistique suffisante pour justifier son emploi comme mesure régulière en chirurgie. Le Prométhazine HCl apporte une réduction de vomissement très significative, compte-tenu des conditions de cette étude et son emploi comme mesure prophylactique contre le vomissement après l'opération, se trouve justifié.

REFERENCES

1. LEE, J. A. A Synopsis of Anaesthesia; John Wright & Sons, Ltd., 1950, pp. 307.
2. DAVIS, R. M. Some Factors Affecting the Incidence of Post-Anaesthetic Vomiting, Brit. Med. Journal. 2: 578, (Oct. 23) 1941.
3. SMITH, J. M. Post-Operative Vomiting in Relation to Anaesthetic Time, Bri. Med. Jour. 2: 2174, (Aug. 18) 1945.
4. BEST, C. E. and TAYLOR, N.B. The Physiological Basis of Medical Practice; The Williams & Wilkins Co., 1950, pp. 574.
5. BARCLAY, A. E. The Digestive Tract, Cambridge University Press, 1933 (Quoted by Best & Taylor).

6. Hewer, C. L. Recent Advances in Anaesthesia & Analgesia, J. A. Churchill Ltd., 1948.
7. Minnit, R. J. A Successful Treatment for Toxic Symptoms Resulting from Ether Anaesthesia Based on Biochemical Investigation, Proc. Roy Soc. Med. (Am. Sec.) (Dec. 2) 1932.
8. Smith, G. R. F. Post-Operative Vomiting, Brit. J. Anaesth. *138*, (July) 1934.
9. Bergman, W. Relief of Post-Anaesthetic Vomiting through Pyridoxine, Canad. M. A. J. *56*: 554, (May) 1947.
10. Kernis, L. and Stodsky, B. Failure of Pyridoxine in Post Anaesthetic Nausea and Vomiting, Anesthesiology *11*: 212, 1950.
11. Hill, F. W. Pyridoxine in the Treatment of Post-Anesthetic Nausea and Vomiting, Anesthesia *6*: 52, (Jan.) 1951.
12. Gay, L. N. and Carlinger, P. E. Science *109*: 359, 1949.
13. Carlinger, P. E., Radman, H.M., and Gay, L. N. Treatment of Nausea and Vomiting of Pregnancy with Dramamine—Preliminary Report, Science *110*: 215, (Aug. 26) 1949.
14. Beeler, J. W., Tillisch, J. H., and Popp, W. C. Proc. Staff Meetings of the Mayo Clinic: (Sept. 14) 1949.
15. Campbell, E. H. The Effectiveness of Dramamine in Relieving the Vestibular Reactions Following the Labyrinthine Fenestration Operation, Laryngoscope *59*: 1261, (Nov.) 1949.
16. Peterson, M. D. Anesthesiology *10*: 767, 1949. (Correspondence).
17. Rudolph, C. J., Park, D. D., and Hamilton, C. Treatment of Post-Anesthetic Nausea and Vomiting, J.A.M.A. *144*: 1283, 1950. (Correspondence).
18. White, J. M., Freedman, D., McCawley, E. L., and Gray, W. D. Effect of Certain Dialkyl-Substituted Aminoalkyl-Bearing Compounds on Ampmorphine-Induced Emesis, Federation Proc. *9*: 325 (March) 1950.
19. Friese, H. B., Bianchi, R. G., and Hambourger, W. E. P. Morphine-Induced Emesis in Dogs Treated with—Dimethylaminoethylbenzohydryl ether-8-Chlorotheophyllinate (Dramamine), Federation Proc. *9*: 274 (March) 1950.
20. Wolfe, W. B. The Use of "Dramamine" in the Prevention of Postoperative Nausea and Vomiting; Ann. Surg., *136*: 261 (1952).
21. Demade, R. and Dulong-de Rosnay, C. H. Action du 3277 R.P. (Phénergan) sur les vertiges et les vomissements tardifs dus à la streptomycine. La Presse Medicale, *56*: 834. (1948) (Abstract).
22. Harper, J. Prevention and treatment of travel sickness with promethazine chlorotheophyllinate, Lancet *1*: 1141 (1951).
23. Glaser, E. M. and Hervey, G. R. The prevention of seasickness with hyoscine, benadryl and phenergan, Lancet *2*: 749 (1951).
24. Bethell, M. F. Prevention of seasickness with hyoscine, benadryl and phenergan. Lancet *2*: 888 (1951).
25. Campbell, H. E. The Statistical Method. Surgery *9*: 825 (1941).

CLINICAL EXPERIENCE WITH SURITAL SODIUM*

G. D. M. Boddington, M.D.**

Surital sodium was introduced to the Canadian market this year as a proven intravenous anaesthetic agent. For this reason it was felt timely to discuss the place of Surital in present day clinical anaesthesia.

It is gratifying to note that Surital has had a long and careful laboratory and clinical trial, over a period of seven years, before it was released to the open market. There have been frequent reports in the literature during these past seven years and many thousands of cases have been reviewed. P. C. Lund (1) has perhaps the largest series with some six thousand cases reported and a total of fifteen thousand anaesthetics in which Surital played a part.

Nor is the present paper the first mention of Surital in the Canadian literature. In an excellent article Gain, Yates, Hoar and Watts (2), reported their experience and suggested that further use of Surital was indicated. This present paper is based on a review of the literature and a relatively small series of cases. One hundred and fifty cases are reported and since the paper was written there have been an additional fifty cases in which Surital has been used.

The series is small because it comprises part of the work of one individual during the spring of 1954. Nevertheless interest has been added by a detailed discussion of several representative cases so that the method of use and the doses employed may be easily followed.

Surital Sodium is also called Thiamylal Sodium. The chemical formula is: Sodium 5-allyl 5-(1 methylbutyl)-2 thiobarbiturate. Surital is the sulphur analogue of Seconal Sodium, just as Pentothal is the sulphur analogue of Nembutal. Because of this close chemical similarity one would expect Surital and Pentothal to be much alike as anaesthetic agents. Surital is an ultra-short acting thio-barbiturate. In this group of cases it was used intravenously in the 2½% solution. Like Pentothal it may be employed by continuous intravenous drip, .03% solution (3), as a hypnotic for psychological or psychiatric examination (4), or by rectal instillation (5).

The present product is much improved over early experimental samples. This point is emphasized because there are many who might remember, with distaste, the thick brown and rather sticky powder which was the earliest product. Surital, as supplied to-day, is a light yellow powder that is easily dissolved in distilled water producing a clear yellow solution. It has a sulphur odour somewhat stronger than that of Pentothal. It is packaged as a fine powder, in ampules or rubber topped vials of one gram each.

Intravenous anaesthesia is admittedly popular with most of us. It has been a very humane contribution to medicine. It is demanded by those of the laity who have previously received it as an anaesthetic. Yet despite all this, intravenous

*Presented at the Annual Meeting, Canadian Anaesthetists' Society at Vancouver, British Columbia, June 15, 1954.

**From the Department of Anaesthesia, Faculty of Medicine, University of Toronto.

anaesthesia has its detractors. Especially is this true since the advent of curare and the combination of an intravenous anaesthetic and a curare-like drug in a rapid injection for facilitating endotracheal intubation. We would be wise to listen to those who warn us, for the very ease of administration of these drugs may lead to respiratory depression. It is thought to-day, that oxygen lack is the greatest single factor in the production of cardiac arrest, whether it stems from short anoxia or long continued hypoxia.

The patient undergoing mitral commissurotomy is a fine index of the effect of rapid throbarbiturate injection. Unless the induction dose is limited to approximately ten cubic centimetres of a two and one-half percent solution, or preferably less, and the induction time spread over ten or fifteen minutes, there is an alarming drop in blood pressure and increase in pulse rate. These factors may result in cancellation of the procedure at hand.

The elderly, the shocked, and the very young patient behave in a similar manner to the patient with mitral stenosis, though often not in such a dramatic fashion. The average young adult does not respond to such a degree and this is probably one reason why the rapid injection technique has stealthily crept to popularity.

The present trend in our thinking (6), is for slower injection with intervals between injections. Not all will agree with this, but we must not let such useful drugs fall into disrepute through lack of consideration of our method of use.

It is with these thoughts in mind that a reiteration of certain basic principles of the use of intravenous anaesthetics is presented. If some points are lacking, or if disagreement is evident, it is hoped that these will be corrected by the discussion.

1. The intravenous anaesthetic should be administered slowly and with a pause between each injection.

2. Lack of oxygen should be guarded against by oxygen administration at the earliest suitable moment. Respiration must always be adequate and failing this, must be assisted.

3. In the elderly, the debilitated or shocked patient intravenous anaesthesia should be used in minimal doses and preferably as an inducing agent only.

4. It is wise never to exceed a total dose of one gram of a thiobarbiturate in any one anaesthetic. This principle was adhered to in the present series.

5. Patients with impaired liver function or severe asthma should never receive a continuous intravenous anaesthetic. Some anaesthetists agree that a minimal dose given carefully may be allowed to facilitate a smooth and humane induction.

6. Atropine or hyoscine should be administered prior to any intravenous anaesthetic.

7. An anaesthetic machine which is suitable for efficient artificial respiration should be available at every administration of an intravenous anaesthetic. It is preferable not to use the intravenous anaesthetic alone even for very short procedures but always to supplement with a high degree of oxygen.

A drop in blood pressure is the usual sequel to the injection of an intravenous anaesthetic. This appears to vary directly with the speed of injection and the

amount of anaesthetic agent used. With a slow induction and pauses between injections, as previously mentioned, the blood pressure drop will be kept to a minimum.

Bigelow (7), has noted that the arterial oxygen saturation may drop ten or more percent during the induction with an intravenous anaesthetic if oxygen administration is not constant and adequate. This may be unimportant in the otherwise healthy young adult but on the other hand it may be extremely dangerous in people with mitral stenosis, other forms of heart disease, hypertension, shock, extreme debility, or the very young or old. In these cases, therefore, our technique should allow gentle oxygen administration by mask concurrently with the intravenous injection. The patient should be advised that the mask will deliver oxygen only and that the intravenous injection will induce a pleasant dreamless sleep.

Breakdown of Cases

There are a total of one hundred and fifty cases in this series. Of these, one hundred and twenty-five were combined anaesthesia where Surital was used throughout in combination with nitrous oxide and oxygen and on occasion with the addition of a relaxant drug alone, or trilene alone, or with both a relaxant and trilene used. D-tubocurarine, Flaxidil, Syncurine and Anectine were the relaxant drugs employed. Surital was used for induction alone in twenty-five cases. In these cases the maintaining anaesthetic agent was cyclopropane, cyclopropane and a relaxant drug, cyclopropane and ether or ether and oxygen given by the anaesthetic machine and employing the endotracheal method. In the latter group cyclopropane was used after the endotracheal tube was passed until the patient was sufficiently anaesthetized to tolerate the gradual introduction of ether into the system. Most of these twenty-five cases were for upper abdominal surgery where maximum relaxation is required. It seems reasonable to many anaesthetists not to employ intravenous barbiturate anaesthesia to maintain these cases. To do so is to add a respiratory depressant without gaining anything in the field of relaxation. It appears wiser to use the more profound anaesthetics in upper abdominal surgery. Then too, we must not neglect the use of spinal anaesthesia which appears to have lost its vogue in recent years with the advent of curare.

Of the one hundred and fifty cases, forty-five were general surgery which included plastic and thoracic surgery. There were thirty-eight gynecological cases, twenty-one orthopaedic cases, eighteen otolaryngological cases, fourteen neurosurgical cases, nine opthalmological cases, eight genito-urinary cases and two dental cases.

Balanced anaesthesia using Surital, nitrous oxide and trilene with or without relaxants has been found a most pleasing combination for gynecology, otolaryngology and orthopaedic surgery: in fact almost anywhere except in upper abdominal surgery. The addition of Trilene has made for better aeration by the reduction in the requirements of Surital and relaxant drugs.

A direct flow system with an easy blow off valve has long been popular in England and has recently had its adherents in the United States (8). Such a

system is to be found in the English Boyle's machine. The Heidbrink machine may be adapted using the Trilene attachment. This system has several advantages over the circle system when using nitrous oxide.

1. There is no carbon dioxide build-up as the large volume of gas prevents return of respiration.

2. It has been shown (10) with the circle system that if the bag is not regularly and repeatedly emptied the nitrous oxide tends to increase at the expense of the oxygen in the system because of oxygen metabolism. In the direct flow and blow-off the nitrous oxide and oxygen remain constant.

3. There is less work for the patient with a large volume, loose blow-off valve and the absence of a return valve.

The rationale behind the direct flow is that the average individual has a tidal exchange of five litres per minute. Most often six to nine litres of gas are employed in the non-rebreathing method which covers the tidal volume, makes it easily available to the patient and prevents re-breathing.

Surital combined with nitrous oxide, oxygen, Trilene and relaxants is, of course, non-explosive.

Endotracheal anaesthesia was used whenever indicated and this was facilitated by the use of anectine intravenously, and on occasion a 5% cyclaine, 2% pontocaine or 4% cocaine spray to the cords and upper trachea.

One death occurred in this series. The patient was a 72 year old man who appeared much older. He was emaciated and lying in bed with side-boards. He had been *non compis mentis* for several years following a stroke which left him hemiplegic. He had suffered two cardiac infarctions and was also suffering from rheumatoid arthritis. Following an attack of pneumonia he had fallen and fractured the neck of his femur. He was nursed at home for ten days but appeared to be in such a state of helpless misery that his relatives found it intolerable and on their persuasion an attempt was made to obtain fixation of the fracture with a Smith-Peterson nail. Surital, 9 c.c. of a 2½% solution was used together with 1 c.c. of Anectine and the patient was intubated and carried on nitrous oxide and oxygen, 4 litres to 2 litres. A further 3 c.c. of Surital and 2 c.c. of Syncurine were used intermittently to control light anaesthesia as evidenced by increasing speed of respiration or objection to the tube. Respirations were periodically assisted, pulse was 96 and blood pressure 120 for three-quarters of an hour, when just prior to pinning the hip, respirations ceased and pulse could no longer be felt. Pure oxygen by manual pressure brought a return of respiration and pulse but both disappeared spontaneously when the actual pinning took place. Oxygen by manual compression was of no avail. Cardiac massage was of course out of the question. The coroner's diagnosis was "operative shock". The operation was a desperate one undertaken for humanitarian motives. The desperate chance would probably have failed with any form of anaesthesia.

Two other patients of similar age both had hips pinned with similar doses of anaesthesia and were responding on being moved to bed. One of these patients had chronic myeloid leukaemia with a spleen as large as a football. In the other case Trilene was used with 4 to 2 nitrous oxide and oxygen after an initial dose of 8 c.c. Surital, 2½%, and 1 c.c. of Anectine and endotracheal intubation, no

other relaxant or intravenous anaesthetic being used. The latter is probably a better anaesthetic for this type of case.

In this series of one hundred and fifty all cases received a total dose of approximately one gram of Surital or less.

In cases of surgery of the eye, and others where the plane of anaesthesia is light, it is useful to spray the cords. This minimizes or eliminates coughing during the operation or on removal of the tube.

All cases for bronchoscopy should be so thoroughly sprayed with local anaesthetic prior to anaesthesia that the procedure could be carried out under the local anaesthesia alone. Here the Surital is used merely for sleep and the protection of the patient from an uncomfortable procedure. Oxygen should always be added, by first flooding through the mask and then a continuous flow down the arm of the bronchoscope.

A more detailed examination of some of the cases is in order to show the doses of anaesthetic used.

Case No. 1. Operation: Dilatation and curetage and posterior colopotomy.

The patient was a 25 year old woman. Surital 2½% was given intermittently up to a total dose of 20 c.c. or one-half gram. Nitrous oxide and oxygen was administered at the rate of 4 litres to 2 litres. There was a drop in pressure during the procedure from 110 systolic to 100 systolic. Generally a patient undergoing this operation or one of similar magnitude will require from 14 to 20 c.c. of the 2½% solution of Surital along with nitrous oxide and oxygen. It is again emphasized that where the circle system is used the bag is emptied periodically and refilled with oxygen to keep the nitrous oxide: oxygen ratio more even. This is done because oxygen is constantly being used in the patient's metabolism. Emptying the bag periodically is especially important in longer procedures where nitrous oxide tends to build up in ratio because of oxygen consumption. The meters may read a ratio of 2 to 1 but this does not mean the patient is receiving this amount after several minutes of anaesthesia.

Case No. 2. Operation: Hysterectomy. Mrs. H. Age: 43.

Thirty-five c.c. of 2½% solution of Surital was used intermittently along with 7 c.c. of D-tubocurarine. Nitrous oxide and oxygen were administered by the semi-closed circle method. The systolic blood pressure pre-operatively was 130 and during the operation dropped to 120 where it remained.

A 19 gauge needle is used and an intravenous infusion started in all cases which will last one hour or longer. In this way a plugged needle is avoided. A 17 or 18 gauge needle should be used if blood is likely to be administered.

In many gynecological procedures and in perineal cases generally the blood pressure may take a profound drop in the recovery room. This appears to be independent of the type of anaesthesia used. It also occurs in addition to the 10 degree drop in systolic pressure seen on moving the patient off the operating room table and into the bed. The patient with this drop in pressure has a slow pulse and closely resembles the picture of neurogenic shock or the shock seen with spinal anaesthesia. Indeed, these people respond rapidly in the same way to analeptics. The syndrome is not identical to the one seen following a carbon

dioxide build-up in the closed absorption technique for in that case there is the preceding rise in blood pressure and increase in depth of respiration.

An attempt has been made to maintain the blood pressure by intermittent injections of methedrine, minims three, intravenously, followed by minims five intramuscularly should the blood pressure tend to fall. This procedure is not always successful and may have to be repeated in the recovery room. It should be pointed out that these patients do not exhibit signs of curare or barbiturate overdosage.

Case No. 3. Operation: Repair of Shoulder Cuff. Mr. F. Age: 52.

This orthopaedic procedure lasted three hours in the semi-sitting position. The patient was supine when induced with Surital given intermittently up to one-half gram. Mixed with the Surital was 3 c.c. of Syncurine. This mixture has been found useful in carefully handling the larger robust individuals with short thick necks and prominent teeth, or permanent artificial bridges. In these patients too, the Macintosh laryngoscope is the instrument of choice as the teeth may be absolutely avoided. In addition to the Surital and syncurine 2½ c.cs. of Anectine were followed by intubation. Oxygen was administered by gentle bag pressure until intubation took place. The patient was carried on nitrous oxide and oxygen, four litres to two. The remainder of the Surital was used intermittently as was intermittent curare up to 5 c.cs. The pulse and blood pressure were maintained throughout. At the end of the operation a large plaster spica was applied; and the patient was placed in bed on his back. He awoke on being returned to bed with no nausea or vomiting. This of course is a boon to this type of case and clearly shows the value of the combined type of anaesthesia for orthopaedic procedures.

Case No. 4. Operation: Mitral Commissurotomy. Mrs. M. Age: 38.

This patient gave a history of decreasing exercise tolerance, shortness of breath, and haemoptyssis, denoting pulmonary hypertension. She also had rhonchi throughout both lungs.

At operation she had a tight mitral valve. Her left lung collapsed poorly and early in the operation she had a mild bronchospasm relieved by gentle bag pressure with ether vapor in oxygen. The anaesthetic was slowly induced over a period of twenty minutes with 11 c.c. of Surital 2½%. She was then given 3 c.c. of syncurine and her larynx and upper trachea were sprayed with 5% cyclaine. Another 1 c.c. of Syncurine was used. The patient was then intubated with a cuffed endotracheal tube. The Macintosh laryngoscope was used to avoid touching her complete front artificial porcelain dentures.

The patient's blood pressure remained absolutely the same during the slow induction. As the patient was slowly becoming drowsy it was explained to her that oxygen would be given by the face mask. This was kept up constantly except for the moments of spraying and intubation.

Her blood pressure dropped to zero on the fracturing of the mitral valve and the visable heart became slow and flabby. It responded quickly to artificial respiration with pure oxygen.

In these cases it is wise to inflate the left lung from time to time and this inflation is imperative if the heart beat changes or the heart muscle loses its tone.

This patient was maintained on ether and oxygen, only three-quarters of an ounce of ether was used during the operation. No further relaxant or Surital was used after the original induction.

It is efficacious to have an assistant, such as one of the anaesthetic internes, help during the commissurotomies, as the constant vigil of watching the patient prevents the anaesthetist from attending to accurate charting and transfusions etc.

Case No. 5. Abbe Repair of Hare Lip. Miss W. Age: 40.

In this procedure the lips are sutured together so that it is imperative to have the patient awake and in control of their reflexes when it is completed and avoid nausea, vomiting and excess mucus.

The patient was slowly induced with an intermittent injection of 12 c.cs. of 2½% Surital. Following this she was given two c.cs. of 2½% Surital, followed by two c.cs. of Anectine intravenously. The nose and pharynx and cords were sprayed with 5% cyclaine. An endotracheal tube was passed gently by the nasal route and "blind" intubation accomplished. During the operation she was carried on nitrous oxide and oxygen, four litres to two litres. A further 8 c.cs. of Surital was given intermittently in one c.c. injections.

The anaesthetic lasted 45 minutes. The blood pressure remained at 120 systolic and the pulse at 84. There was no nausea or vomiting, the patient was stirring at the end of the operation and on removal of the tube she responded to questioning by nodding her head.

Case No. 6. Operation: Lumbar Laminectomy for Extruded Intravertebral Disc. Mr. F. Age: 40.

Surital 2½% solution was given intermittently up to 14 c.c. This was followed by cyclaine 5% spray to the larynx and upper trachea. Oxygen was given by mask intermittently until intubation. An endotracheal tube was passed without the use of relaxant drugs. There was no coughing on the tube. The absence of coughing may be obtained by local spray and is most desirable in neurosurgical operations where there is increased intracranial pressure and in opthalmalogical surgery. Indeed it is ideal wherever the anaesthetic is kept on a light plane.

The patient was placed in the prone position and carried on nitrous oxide and oxygen, 6 litres to 3 litres with the English Boyle's machine, using Trilene in the flow. From time to time further Surital was added intermittently as was Flaxidil. This was found necessary in a large and robust patient. A total of 35 c.c. of 2½% Surital was used as well as 6 c.c. of Flaxidil. The operation lasted 2¼ hours. There was an initial blood pressure drop of 10 points systolic, from 110 to 100. Five minutes later the blood pressure had returned to 110 systolic where it remained. The patient was responding at the end of the operation.

Case No. 7 Operation: Tonsillectomy and Adenoidectomy. Master A. Age: 6.

In order to use Surital by the intravenous route in children it is imperative to gain their confidence and explain the procedure simply. The needle may be

compared to the toxoid injection with which the child is familiar or with the pre-operative atropine injection he has received.

One must be sure that the first venapuncture is successful and it is wise to have the vein optimally distended. A sharp 21 gauge needle is used. This child received 6 c.cs. of 2½% Surital intravenously by intermittent injection, then one c.c. of Anectine followed by oxygen and a further 6 c.cs. of Surital after intubation. The patient was carried on nitrous oxide and oxygen, 6 litres to 3 litres, and Trilene with the Boyle's machine. There was no additional Surital. The patient responded at the end of the operation with no vomiting.

Case No. 8. Operation: Colon Resection. Miss B. Age: 53.

Surital 2½%, 14 c.cs. was given slowly intravenously by intermittent injection followed by Anectine 2 c.cs. An endotrachial tube was passed and the patient was then carried on cyclopropane and oxygen. Six c.cs. of d-tubocurarine were given intermittently into the intravenous tubing.

Case No. 9. Operation: Detached Retina. Mrs. A. Age: 60.

Surital 2½% was given intermittently up to 12 c.cs. This was followed by 2 c.cs. of Anectine. Oxygen was administered all the while. A 5% spray of cyclaine was blown into the cords and into the upper trachea. An endotracheal tube was passed using the Macintosh laryngoscope. The patient was carried on nitrous oxide and oxygen and Trilene using six litres to 3 litres of the gases and employing the Boyle's machine. Intermittent injections of Syncurine up to a total of 5 c.cs. were made.

There was no coughing on removing the tube and the patient was wide enough awake to return to her room lying on her back, which is desirable in the operation for detached retina and which is of course impossible if the patient remains unconscious.

Conclusions

Surital Sodium is a most satisfactory intravenous anaesthetic agent. The close chemical similarity to Pentothal Sodium is borne out clinically where the two agents appear to be best used in equivalent doses.

Those who are familiar with the administration of Pentothal Sodium may safely use Surital Sodium in an identical manner.

The advantages and disadvantages of Pentothal Sodium appear to be true for Surital Sodium.

Summary

1. One hundred and fifty Surital Sodium anaesthetics are reported.

2. A reiteration of the basic rules for the administration of intravenous anaesthetics is presented.

3. Surital combined with nitrous oxide, oxygen and Trilene by the continuous flow system is discussed and advocated.

4. Several cases are examined in detail to emphasize dosage and more clearly explain the administration of this anaesthetic agent.

RÉSUMÉ

1. On rapporte 150 cas d'anesthésie au Surital de Sodium.

2. On présente une réitération des règles fondamentales pour l'administration des anesthésiques intraveineux.

3. On conseille l'emploi du Surital combiné à l'oxyde nitreux, l'oxygène et le Trilène suivant le système de l'écoulement continu.

4. Plusieurs cas sont examinés en détail pour souligner le dosage et pour expliquer plus clairement l'administration de cet agent anesthésique.

Conclusions

Le Surital de Sodium est un agent anesthésique intraveineux très satisfaisant. Sa ressemblance chimique étroite avec le Pentothal de Sodium est confirmée en essais de clinique où des dosages équivalents des deux agents semblent produire les meilleurs résultats.

Ceux qui connaissent la technique d'administration du Pentothal de Sodium peuvent se servir avec sécurité du Surital de Sodium d'une façon identique.

Les avantages et désavantages du Pentothal de Sodium semblent s'appliquer également au Surital de Sodium.

REFERENCES

1. LUND, P. C. Surital Sodium Intravenous Anaesthesia: 6,000 Consecutive Cases. Anesthesia and Analgesia, Vol. 33, No. 2, 1954.
2. GAIN, YATES, HOAR AND WATTS. Clinical Impressions of a New Thiobarbiturate for Intravenous Anaesthesia. C.A.M.J., Jan. 1951.
3. HELRICH, PAPPER AND ROVENSTINE. Surital Sodium, a new Anesthetic Agent for Intravenous Use. Preliminary Clinical Evaluation. Anesthesiology, Vol. 11, No. 1, Jan. 1950.
4. BROWN, E. O. Narcoanalyses with Surital Sodium. Journal of Michigan State Medical Society, Vol. 50, Nov. 1951.
5. HELRICH, DALY AND ROVENSTINE Anesthetic Management of Infants and Children During Endoscopy. Pediatrics, Vol. 6, No. 4, Oct. 1950.
6. STEPHEN, MARTIN and NOWILL. Cardiovascular Reactions of Surital, Pentothal or Evipal Combined with Muscle Relaxants for Rapid Anesthesia Induction. Anesthesia and Analgesia, Vol. 32, No. 6, 1953.
7. BIGELOW, W.G. Personal communication.
8. BAUMGARTEN, O. AND BETCHER, A. M. The Use of the Non-rebreathing Method of Anesthesia. Anesthesiology, Vol. 15, No. 2, 1954.
9. VINING, J. Personal Communication.

ANAESTHESIA FOR INFANTS IN A COMMUNITY HOSPITAL*

V. A. NEKUS, M.D.**

THE practice of Anaesthesia in a community hospital requires great versatility from the anaesthetist. He must possess the ability to deal with many special problems and provide efficient anaesthetic service for any patient admitted for an operation. Many of his patients will be infants, often in poor physical condition, requiring immediate surgery. Knowledge of basic principles of physiology peculiar to this age group will help to provide satisfactory and safe anaesthesia.

The disproportion and weakness of structures interfere with infants' respiratory activity. There is an increased tendency towards respiratory obstruction due to a narrow airway, a large tongue, actively secreting mucus glands, as well as an out of proportion and heavy head, and a very short neck. Weak muscles are unable to expand sufficiently an unstable and elastic infant's chest; a bulky and possibly distended abdomen, on the other hand, may interfere with diaphragmatic excursions. A relatively small alveolar surface and a large dead space further decreases the efficiency of ventilation. The tidal volume of a premature infant may be as low as 5 ccs. This does not represent the volume of gas actually entering and leaving the alveolar air, for a portion of it lodges in the dead space. The metabolic rate, in infants, is very high and requires a large oxygen supply. The small tidal volume is compensated by a rapid respiratory rate.

Infants brought in for emergency surgery, who have been seriously ill, are frequently dehydrated or malnourished. Poor fluid intake, increased demand for fluids or excessive fluid loss due to fever, vomiting or diarrhoea, may seriously disturb fluid and electrolyte balance. Acidosis may be pronounced, and ketone bodies may appear in the urine. Pre-operative correction of electrolyte imbalance, particularly if ketonuria is present, may be required.

Minor degrees of fluid and electrolyte imbalance though are common in sick children and there is little point in attempting to correct it pre-operatively.

An infant with a high fever, subjected to surgery and anaesthesia, most certainly will develop a high pulse rate, collapse and convulsions, especially during the hot summer months. 50 mgms. of Aspirin rectally, antibiotics and sponging of the body with cold water, or alcohol, will bring the temperature below 102°F. per rectum. If convulsions do occur, intravenous injection of a barbiturate (Nembutal) will give dramatic results.

Traumatic cases and infants suffering from surgical or medical conditions associated with blood loss, when the Hgb reading is below 10 gms. should be transfused before the anaesthesia is commenced. In non-dehydrated infants, transfusion with packed cells is more satisfactory. The oxygen carrying capacity will be increased with less danger of over-hydrating the baby with a large volume of blood and over-loading it with sodium chloride. If a bottle of citrated

*Presented at a meeting of the Ontario Division, C.A.S., Ottawa, April 3, 1954.
**From the Department of Anaesthesia, Hôtel Dieu Hospital, Kingston, Ontario.

blood is hung up on an i.v. post for a period of 3 to 4 hours, the blood cells, if not disturbed, will settle down. The lower part, containing cells, may be administered as packed cells.

Pre-operative Feeding and Medication

Infants are usually fed every four hours. Witholding of feedings depletes infants' glycogen stores and fasting for longer than four hours, pre-operatively, may be dangerous. Clear fluids (sweetened water or juice) may be given four hours pre-operatively to infants *NOT* suffering from bowel or pyloric obstruction—the possibilities of vomiting are slight. On the other hand, infants with bowel obstruction may require emptying of their stomach and parenteral administration of glucose.

Every infant, regardless of age and its physical condition, must be given, pre-operatively, Atropine or Scopolamine—the suggested dose being 1/600 of a grain. Infants weighing 15 pounds and over may be given sedation, as well. The rate of absorption of subcutaneously injected drugs, in an ill and dehydrated patient, is unpredictable. In this respect, the intramuscular administration of premedication is preferable. To all newborn babies, Vitamin "K" must be given pre-operatively.

Choice of an Anaesthetic Agent

As a rule, it is stated that any anaesthetic agent that has been used safely in adults can be employed in children. Although one cannot pass by without discouraging the use, in infants, of potent anaesthetic agents, such as Chloroform or Ethyl Chloride. A narrow margin of infant safety is further narrowed by the potency of the agent.

Ether is still considered one of the safest anaesthetic agents. However, if large amounts of Ether, as in deep anaesthesia over prolonged period of time, are used, the liver function may become impaired, glycogenolysis increased, and excessive production of lactic acid may lead towards metabolic acidosis.

Cyclopropane and Nitrous Oxide have very little effect on the metabolism. The former requires the use of a closed system. Its use with a non-rebreathing technique, throughout the operation, is too expensive and, therefore, impractical; on the other hand, if Cyclopropane is used just for short periods of time for induction or when rapid deepening of anaesthesia is required, it may be very valuable. Nitrous Oxide if used with sufficient amounts of Oxygen requires to be supplemented by another anaesthetic agent, in order to produce satisfactory anaesthesia.

It seems that the idea of so-called "balanced anaesthesia", using two or more different agents, each in a relatively small quantity, is a preferential choice when dealing with an infant.

Techniques and Methods

Whatever the choice of an anaesthetic agent might be, the more important factor for a safe and successful anaesthesia is the way the drug is administered. If care is taken to observe basic principles, a baby may be expected to withstand the surgery for a considerable length of time.

1. *Adequate Oxygenation*: An infant depends on its oxygen supply from one inspiration to another and has no oxygen reserve available in the body.

2. *Elimination of CO_2*: Even small increase in CO_2 tension will lead to serious disturbance in infant's physiology, and acidosis will be produced rapidly.

3. *Reduction of Dead Space*: A baby will make no effort to overcome excessive dead space for any length of time. Hypercapnia may be the result of rebreathing from a dead space approximating the tidal volume in size. The smallest mask may increase the total dead space considerably in infants. Most available anaesthetic equipment is out of proportion to infants' tidal volume.

4. *Minimum Resistance*: A respiratory fatigue, during anaesthesia, must be avoided at all costs, in infants. An anaesthetic machine with all its valves, long tubing and resistance created by the CO_2 absorber, is more than an infant can withstand.

5. *As Light a Plane of Anaesthesia as compatible with Surgery*: It is said that an infant is less sensitive to a painful stimulus than adults. Since the margin of safety in babies is narrower, a lighter plane of anaesthesia will increase the safety.

The stages of anaesthesia in infants are more difficult to differentiate than in adults. Eye signs are unreliable, and so are the respirations—rapid and often irregular.

Infants betray light anaesthesia by flexion of their elbows and clenching their fists. The last is a very valuable guide in assessing the depth of anaesthesia.

The plane of anaesthesia just beyond the stage of "clenched fist"—some call it a "grasp reflex"—is sufficiently deep even for abdominal surgery in babies. Arms placed in a manner allowing the anaesthetist to see patient's hand, in spite of surgical draping, will enable him to guide the depth of anaesthesia accordingly. As long as the "grasp reflex" is present: that is, as long as the baby is clenching the fist, anaesthesia is deepened until the fists relax. From here on, the same depth of anaesthesia is carried throughout the operation.

Muscular relaxation is difficult to obtain mantaining a light plane of anaesthesia. Since infants' respirations primarily are of a diaphragmatic nature, "pushing" of the bowel through the abdominal incision is difficult to prevent, even under deep anaesthesia. Decreasing or abolishing the motions of the diaphragm by controlled respirations may remedy the "pushing".

A variety of techniques and methods is used to administer anaesthetics to infants. Some of these require complicated and expensive equipment. Simplicity of techniques and equipment in a small hospital is most valuable. It eliminates mechanical defects as well as expense.

One should remember, though, that no anaesthetic should be started on a baby unless: (a) oxygen with minimum equipment necessary to administer it, (b) a proper size airway, (c) a laryngoscope, (d) an infant size endotracheal tube, and (e) a suction apparatus are on hand, regardless of how simple the technique or how short the anaesthesia is going to be.

The Open Drop Technique has the advantage of simplicity, and provides good anaesthesia. Nevertheless, the danger of hypoxia and CO_2 accumulation is not eliminated, especially when using a heavy covered mask. Such a mask, when wet,

creates considerable resistance and increases the total dead space. The use of towel wrapping around the mask and face is not permissible in infants. Oxygen introduced under the mask at a flow rate of 500 to 1000 ccs./min. will improve the oxygenation and mechanically remove accumulating CO_2.

When dealing with a very small or a very sick and toxic baby with embarrassed respirations, endotracheal anaesthesia should be chosen. The advantages of an endotracheal tube are worth the possible hazards associated with its use. An endotracheal tube: (a) provides a mechanically patent airway and overcomes the possibly increased resistance due to partially obstructed airway; (b) reduces considerably the dead space, since the tube dispenses with nasal and oral pharynx as well as the mask, and therefore lessens the danger of CO_2 accumulation; (c) facilitates the removal of bronchial secretions; (d) facilitates the control of respirations, and (e) enables the anaesthetist to maintain a more even anaesthesia. Gentleness during intubation and the use of a proper size of endotracheal tube will decrease possible mechanical trauma and post-operative respiratory complications.

The ability of a "Portex" tube to mould at body temperature is advantageous and their use in infants is safer than that of rubber tubes. The size of the tube averages, in infants, between 13 to 18 French catheter size, depending on the size of the patient. Too small a tube will decrease the pulmonary ventilation and increase the resistance, while a too large tube will traumatize the larynx, the cords, and the trachea.

Anaesthesia facilitates the intubation, although an attempt to intubate under a light anaesthesia will be most certainly associated with a severe laryngospasm or coughing and "bucking" on the tube. A deep plane of anaesthesia is essential when intubating.

In some instances, the condition of the infant brought in for an emergency operation may not permit the anaesthetist to reach the required depth of anaesthesia before intubating. If the respirations are markedly embarrassed, whether due to interference with respiratory movements or respiratory obstruction, the patient is invariably suffering from hypoxia. Immediate establishment of a clear airway and oxygenation of the baby should be considered life-saving. The same applies to very ill and toxic infants. Those cases have to be intubated while awake. Gentleness of this procedure is of a paramount importance.

The technique of anaesthesia following an intubation depends largely on the available equipment. When an anaesthetic machine is available—I am sure almost every hospital has one—the anaesthetist has a wide choice of anaesthetic agents and techniques.

The use of CO_2 absorption technique in infants requires continuous assistance of respirations and may lead to CO_2 accumulation. The heat accumulation may be tremendous. A closed system anaesthesia requires an expert anaesthetist.

The non-rebreathing technique using a non-rebreathing valve, or a Y tube, are much simpler, require little equipment, and may be used with any type of anaesthetic machine. Both the Y tube and the non-rebreathing valve, if placed close to an endotracheal tube, reduce the dead space and the resistance to a

minimum. They both provide means for artificial respirations. A non-rebreathing valve, such as Stephen-Slater valve, is superior to a Y tube. Assisted and controlled respirations can be carried out more satisfactorily without the danger of exposing the infant to a high intrapulmonary pressure.

Almost any anaesthetic agent may be used with both techniques. Nitrous Oxide with 25–30% of Oxygen, supplemented with small amounts of Ether, seems to be preferred by most.

General Considerations and Supportive Therapy

A close watch of the tiny patient throughout the operation is just as important as a proper anaesthetic technique.

Surgical draping of the patient prevents seeing the respiratory movements of the chest and the abdomen. The movements of the bag are hardly noticeable, due to a small tidal exchange and a high gas-flow. A small stethoscope taped to the chest will enable the anaesthetist to follow the heart and the respirations.

Infants' heat regulation is very poor. This creates a serious problem during hot summer months. The patient under the heavy surgical draping, in an operating-room with room temperature over 80 degrees and a high relative humidity, if no precautions are taken, most probably will develop hyperthermia. An ice bag placed close to the patient's body, number of drapes reduced to a minimum, and sufficient hydration will help to maintain the body temperature below 102°F.

Infants under anaesthesia are particularly prone to develop acidosis. The fluid exchange is very rapid and dehydration or blood loss may lead to shock with considerable speed. The younger the baby, the more these reactions become exaggerated. Fluid replacement therapy is essential during all emergency operations. A vein assured by a cut-down before the beginning of surgery will enable one to carry out satisfactory fluid replacement therapy and will make a blood transfusion possible, if a necessity arises. Blood loss in infants is more satisfactorily replaced with packed cells, as already mentioned.

In general, there is a tendency to give too much fluid when dealing with a small subject. The total amount of parenteral fluids given to an infant depends on its size and the degree of dehydration or the blood loss. The maximum total amount of fluids administered during an operation should not exceed 5 ccs. per lb. of body weight. If active blood loss, due to the operation, is present, the total amount of administered fluids during the operation may be increased up to 10 ccs. per lb. of body weight, including blood transfusion.

In order to achieve the desired results from the fluid therapy, one should remember that (*a*) the blood loss *must* be replaced at the time of its loss; (*b*) saline should be used to a minimum; (*c*) the rate of administration should be as slow as possible; and (*d*) the fluids administered over a period of 24 hours should not amount to over 75 ccs. per lb. of body weight.

Post-Operative Care

Only very fortunate hospitals have a post-anaesthetic Recovery Room. Therefore, as a rule, all infants following a general anaesthesia should remain in the operating-room, where suction apparatus, oxygen, etc. are available. If not

contra-indicated, from the surgical point of view, a baby is best placed in a lateral position. Close watch of the patient, removal of secretions, vomitus, or other material, and maintenance of a patent airway are just as important during the recovery period.

Whenever the intubation is accompanied by a prolonged manipulation or trauma due to technical or other difficulties, serious post-operative respiratory complications may be lessened or avoided by placing the patient in a croupette for at least 24 hours post-operatively. If a croupette is not available, the same can be achieved by placing the child in a cooled oxygen tent. The required high humidity may be supplied by passing oxygen through an Aerosol-Penicillin nebulizer, continuously filling it with water.

In conclusion, it should be emphasized that infant's weak structures, its high metabolic rate, and its exaggerated reactions to stress, require at all times utmost gentleness, strict adherence to techniques and maintenance of anaesthesia assuring good pulmonary ventilation, least disturbance of infant's physiology, and a satisfactory fluid replacement therapy.

Summary

The efficiency of ventilation in infants is poor, due to anatomical and physiological factors peculiar to that age group, while the oxygen demand is very large.

Further disturbance of infants' normal physiology by the disease, fever, dehydration, malnutrition, or anemia greatly increase the anaesthetic problem.

When preparing an infant for surgery, all the above mentioned should be taken into consideration.

In choosing the anaesthetic agent and technique of administration, one should take care to observe the following basic principles:

1. Adequate oxygenation
2. Elimination of CO_2
3. Reduction of dead space
4. Minimum resistance
5. As light a plane of anaesthesia as compatible with surgery.

It is important to select the simplest possible technique which meets all of these requirements. Endotracheal anaesthesia offers certain advantages, and it should be chosen when dealing with very small or very sick children undergoing major surgery. Gentleness and equipment of proper size is very important when intubating an infant. The use of non-rebreathing technique by means of a non-rebreathing valve or a Y tube is advocated.

A close watch of the small patient and adequate fluid replacement therapy throughout the operation cannot be over-emphasized. In order to prevent the danger of over-hydration, the limits for the amount of fluids administered parenterally is laid down to 5 ccs. per lb. of body weight, plus the replacement of actual blood loss during operation.

A close watch of the baby during recovery is a necessity and it is more satisfactorily done right in the operating-room, where the necessary equipment for possible emergencies is available. Following a complete recovery, the infant

may be moved back to the ward. Cool and highly humid atmosphere, such as supplied by a croupette, is recommended for infants where post-operative respiratory complications may be expected.

Résumé

L'efficacité de la ventilation chez les enfants est mauvaise à cause des facteurs anatomiques et physiologiques particuliers à cet âge, alors que l'exigence en oxygène est très grande.

D'autres désordres de la physiologie normale de l'enfant occasionnés par la maladie, fièvre, déshydratation, alimentation défectueuse ou l'anémie augmentent considérablement le problème anesthésique.

On devra tenir compte de tous les facteurs précités en préparant l'enfant pour l'intervention chirurgicale.

En choisissant l'agent anesthésique et la technique d'administration, on prendra soin d'observer les principes fondamentaux suivants: (1) une oxygénation adéquate; (2) l'élimination du CO_2; (3) réduction de l'espace nuisible; (4) résistance minima; (5) un plan d'anesthésie aussi léger que possible et compatible avec l'intervention chirurgicale.

Il est important de choisir la technique la plus simple possible qui répond à toutes ces exigences. L'anesthésie endotrachéale offre certains avantages et sera préférée dans le cas d'enfants très jeunes ou très malades subissant des interventions chirurgicales majeures.

La douceur et un équipment de dimension approprié sont des facteurs très importants en pratiquant l'intubation de l'enfant. L'emploi de la technique du "non-rebreathing" par l'emploi de la valve appropriée ou d'un tube Y est conseillé.

On ne peut trop réitérer la nécessité d'une surveillance étroite du jeune patient et une thérapeutique de remplacement du fluide pendant l'opération. Pour éviter le danger de l'excès d'hydratation, les limites de la quantité de fluides administrés parentéralement sont fixées à 5 ccs. par livre du poids du corps, plus le remplacement de perte actuelle de sang pendant l'opération.

Une surveillance étroite du bébé pendant le rétablissement est essentielle et elle sera observée d'une façon plus satisfaisante dans la salle d'opération même, où l'on disposera de l'équipement nécessaire en vue d'accidents possibles. Après le rétablissement complet on pourra ramener l'enfant dans la salle d'hôpital. Un air froid et très humide comme celui que fournit une croupette, est recommandé pour les enfants dans les cas où l'on peut s'attendre à des complications respiratoires à la suite de l'opération.

REFERENCES

1. Stephen, C. R. C.M.A.J. 63: 109–112: 1950.
2. Gross, R. E. The Surgery of Infancy and Childhood: 1953.
3. Dix, G. W. Bulletin of the Hospital for Sick Children, in Toronto: 2: 42–44: 1953.
4. Stephen, C. R. and Slater, H. M. Paper presented at Fall Meeting of the Montreal Med-Chi Society: October 21, 1948.
5. Stephen, C. R. and Slater, H. M. Curr. Res. Anes. and Anal. 29: 254–262: Sept.–Oct. 1950.

6. STEPHEN, C. R. and SLATER, H. M. C.M.A.J. 64: 22–26: 1951.
7. SLATER, H. M. and STEPHEN, C. R. Arch. of Surg.: 62: 251–259: 1951.
8. STEPHEN, C. R. and SLATER, H. M. Conn. State Med. J. XIII: 109: August, 1949.
9. STEPHEN, C. R. Arch. of Surgery: 60: 1035–1044: June, 1950.
10. STEPHEN, C. R. and SLATER, H. M. Anaesthesiology: 9: 550–552: September, 1948.
11. HARRIS, T. A. B. The Mode of Action of Anaesthetics: 475–619, 1951.
12. SLATER, H. M. and FERGUSON, R. H. Pamphlet—Children's Memorial Hospital, Montreal: 1953.
13. FERGUSON, R. H. Children's Memorial Hospital: Personal Communications.

OXYGEN SUPPLY—A COST-COMPARISON STUDY

By John S. Heron, B.A., M.D., F.A.C.A.*

The demand for administration of oxygen for therapeutic purposes has progressively increased,—so that to-day it is seven times greater than it was ten years ago.

As anaesthetists, we use oxygen every day, but how many of us are aware of the cost of this agent that we employ so casually? At the Toronto East General and Orthopaedic Hospital we obtain oxygen in bulk. From the storage units it is piped to the various hospital departments.

The theoretical advantages of an oxygen piping system from the standpoint of equipment and oxygen economies and better service to patients are well known.

I was curious to determine in dollars and cents how an oxygen piping system had affected this hospital. Therefore, I made a cost comparison of piped oxygen versus cylinder oxygen (by cylinder oxygen I refer to the 244 cu. ft. size cylinder).

The cost of pipe-line installation has been estimated as follows:

1) New construction—such as in our new west wing: $50.–$60. per outlet.
2) Old construction—such as in our old north wing:
   a) exposed piping: $80.–$95. per outlet
   b) concealed piping: $95.–$125. per outlet.

Our present monthly consumption of oxygen averages 80,000 cu. ft. This costs 77 cents per 100 cu. ft.

The *monthly bill* for oxygen at the Toronto East General and Orthopaedic Hospital = *$616.00.*

This volume of oxygen is comparable to that held in 328 cylinders of 244 cu. ft. capacity. On a cylinder basis (excluding handling costs) 100 cu. ft. of oxygen costs 95 cents. The monthly bill for oxygen if obtained in cylinders would be $760.00. This represents a saving on oxygen used of (760–616) = $144.00 per month,—based on the assumption that each cylinder is completely emptied,—whereas in actual practice anywhere from 3 to 15% of the cylinder contents is returned in the "empty tank" which means that the saving is greater than represented here.

A cost study performed at this hospital revealed that the handling of one 244 cu. ft. cylinder of oxygen cost $1.25. Therefore the cost of handling such cylinders for one month would be $328 \times 1.25 = *\$410.00*$.

Consequently the cost of oxygen and handling it in cylinders = (760 + 410) = *$1,170.00.* Thus the oxygen piping system effects a monthly saving of *$554.00.*

It has been estimated that the savings effected on labour alone will pay for

*Toronto East General and Orthopaedic Hospital.

the pipe line at the Toronto East General and Orthopaedic Hospital over a period of five years.

Oxygen Tent

To maintain a 40% concentration of oxygen in a tent the flow rate must be 12 litres/minute. At this rate three tanks are used in a 24 hour period. The handling charges on the oxygen tanks required to maintain one tent in use for one week = $(1.25 \times 3 \times 7)$ = $26.25. The *handling charges* over two weeks will pay for one oxygen outlet in a piped oxygen system.

Nursery

One incubator in the nursery requires one tank of oxygen daily. The monthly saving effected by the use of piped oxygen in the nursery is $50.00 per incubator —which is the cost of one outlet in the piped oxygen system. The figure $50.00 is obtained as follows:

1) $37.50—handling charges for cylinders.
2) $13.00—actual cost of oxygen consumed.

Regulators

When using large cylinders of oxygen it is necessary to employ two stage regulators—these cost $65.00 each and may be overhauled for $25.00.

The pressure in an oxygen piping system is only 50 lb. per square inch compared with 2000 lb. per square inch in a large oxygen cylinder. Therefore a relatively simple and inexpensive flowmeter may be used on the wall outlets of a central oxygen system. The cost of the flowmeters used at the Toronto East General and Orthopaedic Hospital is $16.55 and these may be overhauled for $8.00.

Conclusion

1) The provision of a continuous and adequate supply of oxygen has been effected at considerable saving to the hospital.
2) At the Toronto East General and Orthopaedic Hospital it is felt that in the modern hospital of fifty beds or more, a piped oxygen supply is as essential and as practical as a piped water supply.

A MODEL FOR TEACHING LARYNGOSCOPY

MARJORIE R. BENNETT, M.D.*

A MODEL has been developed for use in teaching laryngoscopy. It is life size, and made of rubber. The original model of the larynx was made of plasticine, and this was given to a commercial artist, who incorporated it in a model of the head and neck minus forehead and crown. An upper plate of false teeth was fastened against the palate. The face is split from the angle of the mouth on each side to the back of the model to permit bending back of the upper half of the head. In this way the larynx can be viewed directly during demonstrations to interns. The epiglottis hangs so that it partially covers the larynx leaving the arytenoids exposed.

There is a slight flexibility to the rubber model, and the procedure of laryngoscopy can be carried out without displacing the top section. On inserting the Macintosh laryngoscope in the proper way, the epiglottis straightens up to expose the larynx just as it does in the patient. The entrance to the oesophagus is seen posterior to the larynx, so the mistake of introducing the blade of the laryngoscope into the oesophagus and lifting the larynx forward can be demonstrated. Technique of introducing a gastric tube during anaesthesia can also be discussed with the help of the model.

*St. Boniface Hospital, St. Boniface, Manitoba.

FIG. 1. Front view.

FIG. 2. Oblique view showing upper half and lower half partially separated.

FIG. 3. View of lower half of model exposing larynx and associated structures.

FIG. 4. Laryngoscopy with Macintosh blade.

FIG. 5. Laryngoscopy with Guedel blade.

NEWS LETTER

The Vancouver Meeting

After returning from British Columbia, late in June, it was pleasant to think in retrospect of the enjoyable, instructive and, at times, socially hectic few days we spent at the Vancouver Meeting. For the Westerners it was a good meeting, and for the Easterners it was a good meeting as well as being a scenic adventure.

The B.C. Division is to be congratulated on the excellent program. In particular, the contributions made by the members of the British Columbia Division were outstanding and they deserve credit for their enthusiasm and scientific enterprise.

The social activities were many and were much enjoyed. The banquet at the panorama roof of the Hotel Vancouver was a splendid and successful affair. The presentation of honorary life membership in the Canadian Anaesthetists' Society to Doctor David Freeze of Vancouver added much to the occasion. Doctor Freeze was happy to receive this commendation from his colleagues. He spoke in an interesting fashion of the progress of Anaesthesia since his days of apprenticeship in the Canadian Expeditionary Force of World War I.

After the organized part of the Meeting was over, the visitors from the east continued to enjoy themselves by visiting Vancouver hospitals. Of these visits we will remember much. We were impressed with the organization of hospital anaesthetic practice, with the excellent coverage provided for obstetrical anaesthesia, and the advanced and efficient organization for the economic aspect of anaesthesia.

Vancouver is undoubtedly a very progressive teaching centre, and all Canadians and visitors from abroad will find much of interest there.

Dr. Wesley Bourne honoured at McGill

At the Spring Convocation of McGill University, Chancellor B. C. Gardner conferred the title of "Professor Emeritus" on Doctor Wesley Bourne. Doctor Bourne commenced his pioneer work in the completely new specialty of Anaesthesia back in 1912. In recognition of his teaching ability, he was appointed the first Professor of Anaesthesia at McGill University in 1942, a position which he held with honor and distinction for a period of ten years.

Doctor Bourne's many friends across Canada will be happy to learn of this honor, which he so richly deserves.

Doctor Karl E. Hollis, former Superintendent of Sunnybrook Hospital, has been appointed representative of The Canadian Commission on Hospital Accreditation. Doctor Hollis was for many years a member of The Anaesthetic Staff of the Toronto Western Hospital and was Head of that Department for some time prior to his enlistment in the R.C.A.M.C. in World War II. He held the rank of Lieutenant-Colonel and was Commanding Officer of Chorley Park Military Hospital and later the hospital ship "Lady Nelson". Following his demobilization, he was appointed Superintendent of Sunnybrook Hospital, Toronto, a position which he held until the time of his retirement last year.

BOOK REVIEWS

A SYNOPSIS OF ANAESTHESIA by J. Alfred Lee (3rd ed.). Bristol: John Wright & Sons Limited. Price $3.60.

This new edition of Lee's "Synopsis of Anaesthesia" brings a very excellent book up to date in the presentation of the changes in theory, the use of recently developed drugs and the accepted advances in technique.

The two new chapters on the methods of reducing bleeding during operations and on the therapeutic application of anaesthesia and analgesia are very necessary for the teaching of the young anaesthetist.

Although this edition is again called a "Synopsis" it contains 483 pages of small print of which 24 pages are index so that it could very well be called a text book.

It is a most useful book for students and is a handy reference book for practicing anaesthetists. Another attractive feature is the low price.

S. M. C.

TRICHLORETHYLENE ANAESTHESIA by Gordon Ostlere. The Macmillan Company of Canada Limited. Price $1.30.

This volume is an excellent little monograph on trichlorethylene, covering the history of the use of the drug, the pharmacology, and its use in anaesthesia. The advantages and disadvantages of trichlorethylene are well described, and the discussion of the proper methods of using the drug is excellent. The literature on the subject has been well reviewed, and this volume is recommended to the attention both of those who have found in trichlorethylene a useful addition to the anaesthetists' armamentarium, and to those who are still dubious of its place in anaesthesia.

R. A. G.

LOCAL ANALGESIA: ABDOMINAL SURGERY by R. R. Macintosh and R. Bryce-Smith. The Macmillan Company of Canada Limited. Price $3.85.

The authors' declared intent to produce—"a clearly illustrated book with simple instructions"—is admirably executed in this volume. The material is presented largely in a series of excellent drawings, with the minimum of text. The authors include brief discussions of indications for local anaesthesia, drugs and their toxicity, general considerations of techniques in employing local analgesia in the abdomen, the relevant anatomical details and techniques for performance of the various local anaesthetic blocks of the abdomen.

R. A. G.

ANAESTHESIA

Published for The Association of Anaesthetists of Great Britain & Ireland

EDITORIAL BOARD

Editor:

C. LANGTON HEWER, M.B., M.R.C.P.: F.F.A.R.C.S.

Assistant Editor:

R. BLAIR GOULD, M.B., Ch.B., F.F.A.R.C.S.

The Executive Officers of the Council:

GEOFFREY ORGANE, F.F.A.R.C.S., *President*

Representative for Scotland:

J. GILLIES, C.V.O., F.R.C.S.E., F.F.A.R.C.S.

The Journal contains articles written by many of the leading anaesthetists together with Reports on New Inventions and a comprehensive List of articles published on the specialty in Great Britain and America. . . . It is issued Quarterly for Association Members and Subscribers and has an increasing world-wide circulation.

Annual Subscription, $7.00 including postage
Single copies, $1.75

"ANAESTHESIA" PUBLISHING OFFICE
24 THAYER STREET, LONDON, W.1., ENGLAND

CANADIAN ANAESTHETISTS' SOCIETY JOURNAL

Index of Authors and Subjects

Volume 1

CANADIAN ANAESTHETISTS' SOCIETY JOURNAL

Volume 1

INDEX OF AUTHORS

Best, Douglas, Why use spinal anaesthesia in obstetrics? 10

BENNETT, MARJORIE, A model for teaching laryngoscopy, 123

BODDINGTON, G. D. M., Clinical experience with surital sodium, 104

Campbell, S. M., Correspondence, 49

CAPLIN, DOREEN, (with GORDON, R. A., VANDEWATER, S. L., and SLEATH, G. E.), A study of the value of dimenhydrinate and promethazine hydrochloride in the control of post-anaesthetic vomiting, 95

CARROLL, JOHN J. (with DENNIS, J. W.), The use of short acting muscle relaxing drugs in obstetrical anaesthesia, 82

— (with PERCHESON, P. B.), Hydergine therapy of uterine inertia, 87

Dennis, J. W., (with CARROLL, JOHN J.), The use of short acting muscle relaxing drugs in obstetrical anaesthesia, 82

Fleming, Shirley A., The clinical use of laudolissin, 13

FORTIN, GUY, (with LÉTIENNE, RENÉ), Prophylaxis and treatment of cardiac arrest, 24

FOULKS, JAMES G., The use of sympathomimetic amines in the treatment of shock, 1

Gordon, R. A., Clinical experience with Hexylcaine hydrochloride (Cyclaine), 19

— (with VANDEWATER, S. L., SLEATH, G. E., and CAPLIN, DOREEN), A study of the value of dimenhydrinate and promethazine hydrochloride in the control of post-anaesthetic nausea and vomiting, 95

Heron, John S., Oxygen supply—a cost-comparison study, 121

Létienne, René, (with FORTIN, GUY), Prophylaxis and treatment of cardiac arrest, 24

MacMillan, Angus, Peridural anaesthesia for obstetrics, 75

MINUCK, MAX, Complications arising during transurethral resection of the prostate, 59

Nekus, V. A., Anaesthesia for infants in a community hospital, 113

NIX, NELSON, The anaesthetist's role in the care of respiratory poliomyelitis, 32

Percheson, P. B., (with CARROLL, JOHN J.), Hydergine therapy of uterine inertia, 87

Ruston, F. G., Epidural anaesthesia in infants and children, 37

Sleath, G. E., (with GORDON, R. A., VANDEWATER, S. L., and CAPLIN, DOREEN), A study of the value of dimenhydrinate and promethazine hydrochloride in the control of post-anaesthetic nausea and vomiting, 95

STEPHEN, C. R., How safe is spinal anaesthesia in present day practice? 67

Vandewater, S. L., The competitive muscle relaxants, 45

— (with GORDON, R. A., SLEATH, G. E., and CAPLIN, DOREEN), A study of the value of dimenhydrinate and promethazine hydrochloride in the control of post-anaesthetic nausea and vomiting, 95

INDEX OF SUBJECTS

Amines, sympathomimetic, use of in treatment of shock [Foulks], 1

Anaesthesia

epidural in infants and children [Ruston], 37

for infants in a community hospital [Nekus], 113

obstetrical, why use spinal in? [Best], 10; Editorial, 57; peridural anaesthesia for [MacMillan], 75; use of short acting muscle relaxants in [Dennis & Carroll], 82

peridural, for obstetrics [MacMillan], 75

regional, with Hexylcaine [Gordon], 21

spinal, why use in obstetrics? [Best], 10; with Hexylcaine [Gordon], 21; how safe in present day practice? [Stephen], 67; complications [Stephen], 70

topical, with Hexylcaine [Gordon], 21
Anaesthetist
role in care of respiratory poliomyelitis [Nix], 32
role in diagnosis and treatment of cardiac arrest [Fortin, Létienne], 24

Book reviews
Local Analgesia: Abdominal Surgery: R. R. Macintosh and R. Bryce-Smith, 127
A Synopsis of Anaesthesia: J. Alfred Lee (3rd ed.), 127
Trichlorethylene Anaesthesia: Gordon Ostlere, 127
Bourne, Dr. Wesley, 126
British Medical Association Meeting, 52

Cardiac arrest
causes, 24
diagnosis, 27
prophylaxis and treatment of [Fortin, Létienne], 24, 25
treatment, 28
Children, epidural anaesthesia in infants and [Ruston], 37
Clinical experience
with Hexylcaine hydrochloride [Gordon], 19
with surital sodium [Boddington], 104
Clinical use of Laudolissin [Fleming], 49
Complications
peridural anaesthesia [MacMillan], 80
spinal anaesthesia [Stephen], 70
during transurethral resection of prostate [Minuck], 59
Correspondence, 49
Cyclaine: *see* Hexylcaine

Dimenhydrinate, a study of the value in control of post-anaesthetic vomiting [Gordon *et al.*], 95
Doucet, Jean-Charles (Obituary), 55
Dramamine: *see* Dimenhydrinate

Editorial, Obstetrical anaesthesia, 57
Epidural anaesthesia: *see* Anaesthesia, epidural

Gravol: *see* Dimenhydrinate

Haemolysis in transurethral resection of prostate [Minuck], 59
Heart: *see* Cardiac
Hexylcaine hydrochloride, clinical experience with [Gordon], 19
Hollis, Dr. Karl, 126
Hydergine therapy of uterine inertia [Percheson, Carroll], 87

Infants
anaesthesia for, in a community hospital [Nekus], 113
epidural anaesthesia in [Ruston], 37
Inertia, uterine, hydergine therapy of [Percheson, Carroll], 87

Laryngoscopy, a model for teaching [Bennett], 123
Laudolissin, clinical use of [Fleming], 13

Meetings
British Medical Association, 1955, 52
reports of, 53, 126
World Congress of Anaesthesiologists, 50, 51
Muscle relaxants
"Competitive" [Vandewater], 45
short acting in obstetrical anaesthesia [Dennis, Carroll], 82

News Letter, 126

Obituary, Jean-Charles Doucet, 55
Obstetrical anaesthesia: *see* Anaesthesia, obstetrical
Oxygen supply, a cost-comparison study [Heron], 121

Peridural anaesthesia for obstetrics [MacMillan], 75
Phenergan: *see* Promethazine
Poliomyelitis, respiratory, anaesthetist's role in care of [Nix], 32
Promethazine hydrochloride, study of the value of, in control of post-anaesthetic nausea and vomiting [Gordon *et al.*], 95
Prostate, complications arising during transurethral resection of [Minuck], 59

Relaxing drugs: *see* Muscle relaxants

Shock, use of sympathomimetic amines in treatment of [Foulks], 1
Spinal anaesthesia: *see* Anaesthesia, spinal
Surital sodium, clinical experience with [Boddington], 104
Sympathomimetic amines, use in treatment of shock [Foulks], 1

Teaching, laryngoscopy, a model for [Bennett], 123

Vomiting, post-anaesthetic, value of dimenhydrinate and promethazine hydrochloride in control of [Gordon *et al.*], 95

World Federation of Societies of Anaesthesiologists, 50

THE CANADIAN ANAESTHESISTS' SOCIETY JOURNAL

Editor
R. A. GORDON

Editorial Board
ALAN B. NOBLE
LOUIS LAMOUREUX
E. A. GAIN

VOLUME 1, 1954

Printed and Published for
THE CANADIAN ANAESTHETISTS' SOCIETY, Incorporated
526 Medical Arts Building, Toronto 5, Canada
by
University of Toronto Press
University of Toronto
Toronto 5, Ontario, Canada
Copyright Reserved

CONTENTS

Volume 1

NUMBER 1, JULY, 1954

The Use of Sympathomimetic Amines in the Treatment of Shock — JAMES G. FOULKS, M.D. 1

Why Use Spinal Anaesthesia in Obstetrics? — DOUGLAS BEST, M.D. 10

The Clinical Use of Laudolissin — SHIRLEY A. FLEMING, B.A., M.D., F.F.A.R.C.S. 13

Clinical Experience with Hexylcaine Hydrochloride (Cyclaine) — R. A. GORDON, C.D., B.SC., M.D., F.R.C.P.(C), F.F.A.R.C.S. 19

Prophylaxis and Treatment of Cardiac Arrest — GUY FORTIN, M.D., and RENÉ LÉTIENNE, M.D., F.R.C.P.(C) 24

The Anaesthetists' Role in the Care of Respiratory Poliomyelitis — NELSON NIX, M.D., F.A.C.A. 32

Epidural Anaesthesia in Infants and Children — F. G. RUSTON, M.D. 37

The "Competitive" Muscle Relaxants — S. L. VANDEWATER, M.D., F.R.C.P.(C) 45

Correspondence 49

World Federation of Societies of Anaesthesiologists 50

British Medical Association Meeting 52

Reports of Meetings 53

Obituary: Jean-Charles Doucet (1902–1954) 55

NUMBER 2, OCTOBER, 1954

Editorial: Obstetrical Anaesthesia 57

Complications Arising during Transurethral Resection of the Prostate — MAX MINUCK, M.D. 59

How Safe is Spinal Anaesthesia in Present Day Practice? — C. R. STEPHEN, M.D. 67

Peridural Anaesthesia for Obstetrics — ANGUS MACMILLAN, M.D., C.M. 75

The Use of Short Acting Muscle Relaxing Drugs in Obstetrical Anaesthesia — J. W. DENNIS, M.D., and JOHN J. CARROLL, M.D. 82

Hydergine Therapy of Uterine Inertia — P. B. PERCHESON, M.D., F.R.C.P.(C) and JOHN J. CARROLL, M.D. 87

A Study of the Value of Dimenhydrinate and Promethazine Hydrochloride in the Control of Post-Anaesthetic Vomiting
R. A. GORDON, M.D., F.R.C.P.(C), F.F.A.R.C.S., S. L. VANDEWATER, M.D., F.R.C.P.(C), G. E. SLEATH, B.A., M.D., and DOREEN CAPLIN, M.D. 95

Clinical Experience with Surital Sodium G. D. M. BODDINGTON, M.D. 104

Anaesthesia for Infants in a Community Hospital V. A. NEKUS, M.D. 113

Oxygen Supply—A Cost-Comparison Study
JOHN S. HERON, B.A., M.D., F.A.C.A. 121

A Model For Teaching Laryngoscopy MARJORIE R. BENNETT, M.D. 123

News Letter 126

Book Reviews 127

Just Published!

40 Leaders Cover Modern

ANESTHESIOLOGY

Edited by **DONALD E. HALE, M.D.**

40 LEADERS come together and present a *comprehensive coverage of modern Anesthesiology.* They consider not only the proper anesthetic agent, but the special importance of the proper technique, the diagnostic and therapeutic considerations for the individual patient. *Safe anesthesia* is the constant keynote of this momentous new book.

FROM THE PREFACE: "A comprehensive volume on the art and practice of anesthesia written by many authors has never before appeared in this country. This volume is in fact a symposium of North American teaching and opinion.

". . . There is no agent used by the anesthetist which is not potentially dangerous. The success with which any of these is used depends less on the qualities of the agent itself than on the anesthetist's knowledge of it and his skill in its administration. The contributors throughout this book stress safety in anesthesia."

770 Pages **149 Illustrations**

F. A. DAVIS CO., *Publishers*

F. A. DAVIS Co., 1914 Cherry St., Phila. 3, Pa.

Please send postpaid and charge to my account ANESTHESIOLOGY by Hale, $15.00.

Name .....

Address .....

.....

Available at

The RYERSON PRESS
299 Queen St. West, Toronto 2B

CANADIAN ANAESTHETISTS' SOCIETY

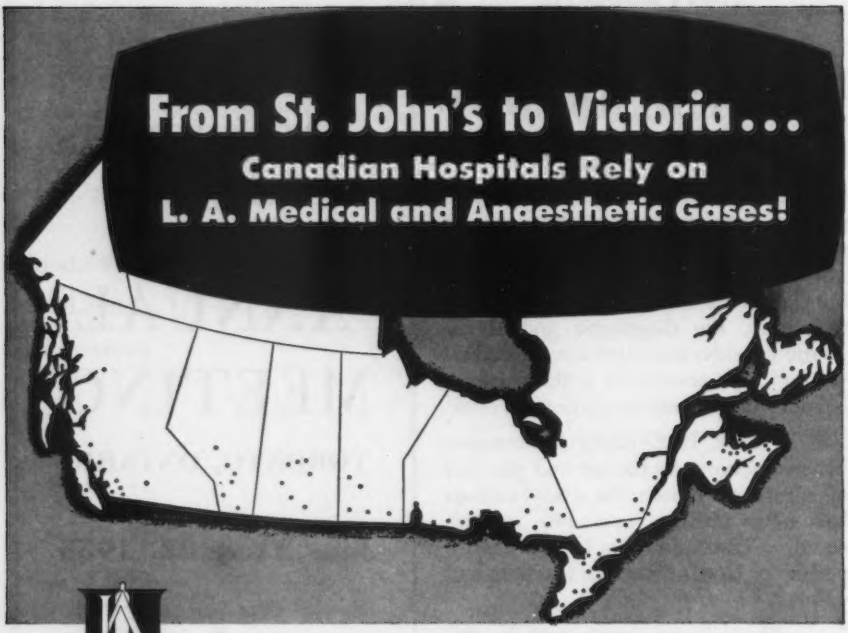
ANNUAL MEETING

TORONTO, ONTARIO

June 21 & 22, 1955

The meeting is to be held in conjunction with the joint meeting of The British Medical Association and The Canadian Medical Association, and preceding the joint meeting of the Sections on Anaesthesia of these Associations.

Plan Now to Attend



Right across Canada, L.A. Medical and Anaesthetic Gases are available whenever and wherever they're needed. L.A. hospital gases can be depended on for utmost purity . . . L.A. equipment for gas distribution and use is of highest quality and latest design. These factors . . . plus the prompt services of specially trained Medical Gas Division representatives whenever technical repairs are needed . . . earn and maintain Canadian Liquid Air's reputation for *reliability*!

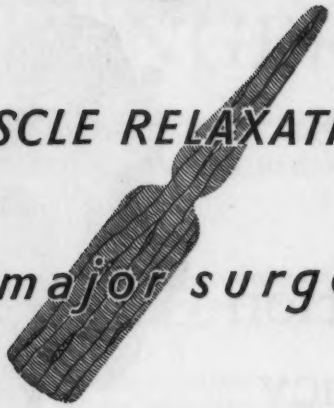
For complete information concerning L.A.'s medical gases, pipe-line systems and outlet equipment, consult the nearest branch office of

MEDICAL GAS DIVISION

Canadian **LIQUID AIR** Company

LIMITED

St. John's, Sydney, Halifax, Moncton, Quebec, Montreal, Toronto, Hamilton, Waterloo, London, Windsor, Sarnia, Port Arthur, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Cranbrook, Vancouver, Victoria.



MUSCLE RELAXATION

in major surgery

LAUDOLISSIN, a new synthetic muscle relaxant has been developed in the laboratories of Allen & Hanburys Ltd. It is a true curarising agent and exerts its effect by blocking the action of acetylcholine at the motor end-plate. It is therefore antagonised by neostigmine.

LAUDOLISSIN has been used with success in a wide range of major abdominal and thoracic surgical procedures in which prolonged relaxation is required. In the suggested dosage, it produces a paralysis which commences 2 to 5 minutes after injection and which lasts for 40 to 50 minutes.

Injection of LAUDOLISSIN is supplied in 10 c.c. vials and ampoules containing 2 c.c. in boxes of 5 or 100 ampoules.

LAUDOLISSIN

(Injection of Laudexium Methylsulphate)

A Synthetic Muscle Relaxant for Intravenous Use

Complete literature on request

254-O

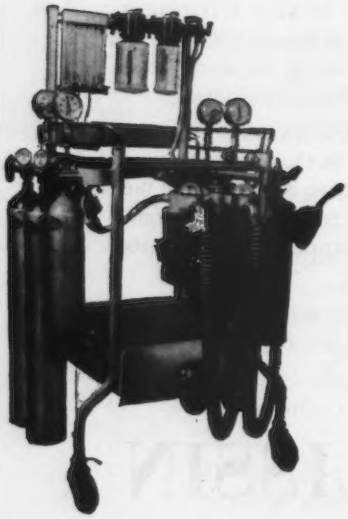
ALLEN AND HANBURYS COMPANY LIMITED
TORONTO ONTARIO · LONDON ENGLAND

BOC CANADA

MEDICAL DIVISION

For Absorption Efficiency

The Boyle Circle
Carbon Dioxide Absorber



A standard component of the Model "H" Boyle Anaesthetic Apparatus, represents the acme of absorber design. The main body is a leakproof casting, incorporating an ether vapourizer fitted with concentric copper baffle tubes which cause the inspired gases to impinge many times on the surface of the ether and, in addition, ensure maximum heat conduction.

Wide bore channels throughout the circuit and gravity type unidirectional valves mounted on knife edge seatings reduce resistance to a minimum.

for further details please contact:

THE BRITISH OXYGEN CANADA LIMITED

Oxygen: Oxygen/Carbon Dioxide Mixtures
Nitrous Oxide: Cyclopropane: Carbon Dioxide:
Helium: Helium and Oxygen Mixtures.

Specialists in Anaesthetic Equipment
HORNER AVE., ETOBICOKE
TORONTO 14, ONT.

ANAESTHETICS ARE DANGEROUS

"BOY PATIENT KILLED WHEN GAS BAG EXPLODES DURING OPERATION"

(Reprinted from the Newark News)

"EASTON, Pa.—A 7-year-old boy died yesterday in Easton Hospital from internal injuries suffered when a gas bag exploded as he was undergoing an operation. The explosion also caused injury to two physicians and a nurse.

The machine which had pumped the anaesthetic had been turned off. Oxygen had been substituted and was being administered to "wash out" the patient's system. Cyclopropane remained in the gas bag, however, and it was that gas which exploded."

"DEATH UNDER ANAESTHESIA"

(Reprinted from Newsweek Magazine)

"In an Evanston, Ill. hospital, an anaesthesia machine exploded, killing a Roman Catholic priest as he lay on an operating table for a stomach-ulcer surgery. In a Brooklyn, N.Y. delivery room, a similar blast killed a woman in childbirth. About 100 times a year, accidents of this nature occur in hospitals, either killing or seriously injuring patients. Operating rooms, with their jungle of electrical equipment and inflammable anaesthetic gases, are natural sites for explosions. The patients take most of the risk of explosions because their lungs may be full of gaseous mixtures, such as nitrous oxide, cyclopropane and ether.

It is up to the hospitals to equip their operating rooms with the necessary devices to prevent this peril."

ELECTROSTATIC DETECTION is the FIRST SAFEGUARD

For information on Electrostatics in hospital operating rooms and the Hewson Static Alarm System, write to:

POWERLITE DEVICES, LIMITED

1870 DAVENPORT ROAD TORONTO 9, ONTARIO

5426

control

degree and duration of muscle relaxation

Controllability is the outstanding advantage of 'Anectine.' It is the result of rapid onset of action, followed by rapid inactivation of the drug by hydrolysis.

Response to alteration of the rate of flow of an intravenous drip of 'Anectine' is apparent in 30 to 60 seconds; therefore the rate required to provide adequate flaccidity, yet retain spontaneous respiration, is quickly determined. Relaxation can then be increased or decreased, within a matter of seconds, according to operative needs. Recovery of muscle tone begins immediately on stopping the infusion.

Speed, both in onset of action and recovery, characterizes single injections of 'Anectine.' So administered, it is dramatically effective for overcoming laryngospasm and for facilitating endotracheal intubation.

'Anectine' *brand*

SUCCINYLCHOLINE CHLORIDE

Injection . . . 20 mg. in each cc.
Multiple-dose vials of 10 cc.
Ready for intravenous injection.

Solution . . . 50 mg. in each cc.
Ampuls of 10 cc.
To be diluted for preparation of intravenous drip solution.

For full information, write to —

Burroughs Wellcome & Co. *(The Wellcome Foundation Ltd.)* *Montreal*

THE CANADIAN ANAESTHETISTS' SOCIETY JOURNAL

Editorial Policy

The Canadian Anaesthetists' Society Journal is published quarterly by the Canadian Anaesthetists' Society Inc. Original articles are accepted for publication on the understanding that they are contributed exclusively to this journal and become the property of the Canadian Anaesthetists' Society. Articles are subject to such alteration as the Editor in his absolute discretion may deem necessary, but no major alterations will be made without consent of the Author.

Manuscripts

Articles should be typewritten in double space on one side of the paper only. Pages must be serially numbered, and each page should carry at its head the name of the author and the title of the article in full or in an appropriate abbreviation. The article should be concluded by a summary which will be intelligible without reference to the main text. All articles should be accompanied by a résumé presenting the important features in short form, for translation into the French language. French-speaking authors should provide this résumé in the French language.

References to the literature should be clearly indicated in the text by arabic numerals in brackets, thus (4). They should be set out in numerical order at the end of the article, typed in double space, as follows:

4. Griffith, H. R. & Johnston, G. E. The Use of Curare in General Anaesthesia. Anesthesiology 3: 481 (1942).

References to books will state in order: Name of Author, Title of Book, Edition, Place of publication, Publisher, Year of Publication, such as:

Labat, G. Regional Anesthesia. 1st ed., Philadelphia: Saunders (1922).

The names of all authors will be given in the first instance in each reference. In further references to the same authors the abbreviated form "Griffith *et al.*" may be used.

Illustrations

Photographs should be unmounted glossy prints. Drawings and charts should be in black India ink on white paper. Reproductions in colour will be undertaken only at the expense of the author. All illustrations must be referred to in the text by Arabic Numerals (thus—Figure 3) the corresponding Arabic Numeral being clearly marked on the back of the illustration, together with the name of the author and the title of the article. Legends for illustrations must be typewritten in double space on a separate sheet of paper and clearly marked with the numerals corresponding to the appropriate illustrations.

Proofs

Galley proofs and engraver's proofs will be sent to the author and to the Editor for correction. A limited time will be allowed for return of proof from the Author, but in the event that Authors do not return proofs within the time allowed, the Editor may proceed to publish the article without awaiting return of proof from the Author.

Reprints

Authors' price list and order blank for reprints will be sent with galley proofs. Order for reprints must be returned with galley proofs to the Editor; otherwise reprints cannot be furnished at these prices.

CONTENTS

VOL. 1, NO. 2 OCTOBER, 1954

Editorial: Obstetrical Anaesthesia 57

Complications Arising during Transurethral Resection of the Prostate
MAX MINUCK, M.D. 59

How Safe is Spinal Anaesthesia in Present Day Practice?
C. R. STEPHEN, M.D. 67

Peridural Anaesthesia for Obstetrics ANGUS MACMILLAN, M.D., C.M. 75

The Use of Short Acting Muscle Relaxing Drugs in Obstetrical Anaesthesia J. W. DENNIS, M.D., and JOHN J. CARROLL, M.D. 82

Hydergine Therapy of Uterine Inertia
P. B. PERCHESON, M.D., F.R.C.P.(C) and JOHN J. CARROLL, M.D. 87

A Study of the Value of Dimenhydrinate and Promethazine Hydrochloride in the Control of Post-Anaesthetic Vomiting
R. A. GORDON, M.D., F.R.C.P.(C), F.F.A.R.C.S., S. L. VANDEWATER, M.D., F.R.C.P.(C), G. E. SLEATH, B.A., M.D., and DOREEN CAPLIN, M.D. 95

Clinical Experience with Surital Sodium G. D. M. BODDINGTON, M.D. 104

Anaesthesia for Infants in a Community Hospital V. A. NEKUS, M.D. 113

Oxygen Supply—A Cost-Comparison Study
JOHN S. HERON, B.A., M.D., F.A.C.A. 121

A Model for Teaching Laryngoscopy MARJORIE R. BENNETT, M.D. 123

News Letter 126

Book Reviews 127

Index, Volume I 129